

O

T

S

19970724 084
T

AR-010-154

DSTO-QD-0130

A Programmer's Reference to the
Suppressor Simulation System

Robert Whitehurst, Jane Phipps and
Victor Kowalenko

APPROVED FOR PUBLIC RELEASE

© Commonwealth of Australia

A Programmer's Reference to the Suppressor Simulation System

Robert Whitehurst, Jane Phipps and Victor Kowalenko

**Air Operations Division
Aeronautical and Maritime Research Laboratory**

DSTO-GD-0130

ABSTRACT

This is a comprehensive reference to the Suppressor Simulation System, a powerful and flexible computer code which allows models of integrated military operations to be put into an Australian context. Such mission level models are vital ingredients to models of entire military campaigns.

RELEASE LIMITATION

Approved for public release

DEPARTMENT OF DEFENCE

DEFENCE SCIENCE AND TECHNOLOGY ORGANISATION

Published by

*DSTO Aeronautical and Maritime Research Laboratory
PO Box 4331
Melbourne Victoria 3001*

*Telephone: (03) 9626 7000
Fax: (03) 9626 7999
© Commonwealth of Australia 1997
AR-010-154
February 1997*

APPROVED FOR PUBLIC RELEASE

A Programmer's Reference to the Suppressor Simulation System

Executive Summary

This document is a comprehensive reference to the Suppressor Simulation System, an extensive and flexible computer code for the modelling large scale military operations. This simulation system, which is usually referred to simply as 'Suppressor', was initially commissioned to study Warsaw Pact penetration of NATO air defences. Suppressor's importance to AMRL lies in its ability to model the interactions of systems whose properties are defined by the analyst. Because of this military scenarios modelled with Suppressor can employ ADF equipment in an Australian operational context. This reference manual organizes all the instructions making up the Suppressor language in an hierarchical fashion. This allows for easy cross referencing of commands and eases the development of locally relevant scenarios.

This reference manual is a companion to the guide to the Suppressor system which describes in much more detail the rationale of the Suppressor system and which is intended as a neophyte's introduction to the language. With these two documents it will be possible to construct complex and meaningful large scale models of military operations on a pan-Australian scale with the aid of the Suppressor Simulation System.

DTIC QUALITY INSPECTED 3

Contents

1. THE TYPE DATA BASE	1
1.1. PLAYER STRUCTURE	6
1.2. THE TACTIC BLOCK	8
1.2.1. Co-ordination	8
1.2.2. Movement	12
1.2.3. Resource Allocation	31
1.3. THE SUSCEPTIBILITY BLOCK	60
1.4. THE CAPABILITY BLOCK	64
1.4.1. Mover	64
1.4.2. Weapon	67
1.4.3. Thinker	74
1.4.4. Communication Receiver	76
1.4.5. Communication Transmitter	79
1.4.6. Disruptor	81
1.4.7. Sensor Transmitter	86
1.4.8. Sensor Receiver	92
 2. THE SCENARIO DATA BASE	 118
2.1. SDB	119
2.2. NET-TYPE	122
2.3. DEFINED-SHARED-ZONES	124
2.4. SIDE	128
2.5. COMMAND CHAIN	128
2.6. PLAYER	128
2.7. LOC	130
2.8. ELEMENT	131
2.9. SYSTEM	132
2.10. TURN	133
2.11. POINT IT	133
2.12. FREQ	135
2.13. ALT-FREQ	135
2.14. FOCUS	136
2.15. PLANS FOR MOVEMENT	136
2.16. PATH	138
2.17. BOUNDARY	141
2.18. MODES OF-CONTROL	142
2.19. ZONE	143
2.20. USE-SHARED-ZONES	146
2.21. KNOWS	146
2.22. TOLD ABOUT	148
 3. TIME HISTORY DATA ITEMS	 149

The Type Data Base

1. The Type Data Base

The input of the data items in the TDB is in a fixed form which can be loosely categorized into five types, as described below. Note that some data items do not fall into any category and these will be discussed as they arise.

1. Dimensional Format

```
DATA-ITEM-NAME
  DIMENSION 1  DIM-NAME  <units>
    <input1>  <input1> ...
  DIMENSION 2  DIM-NAME  <units>
    <input2>  <input2> ...
  INPUT-ITEM
    <input3>  <input3> ...
END DATA-ITEM-NAME
```

The number of dimensions and the form of the <input> varies and <units> are not always present. The precise syntax will be apparent from the description of the appropriate data item. The values entered in the first dimension list form intervals, with each item in the second dimension list occurring once for each of these intervals. Likewise the values entered in the second dimension list form intervals for which corresponding <input3> exist for the third list and so on. A simple example is:

```
ANTENNA-PATTERN
  DIMENSION 1  AZ  (DEG)
    0.0  60.0  180.0
  DIMENSION 2  EL  (DEG)
    -90.0 -65.0 -25.0 -5.0  20.0  40.0  80.0  90.0
  GAIN (dB)
    -20.0 -5.0  20.0  30.0  15.0  5.0 -10.0
  DIMENSION 2  EL  (DEG)
    -90.0 -5.0  20.0  30.0
  GAIN (dB)
    -25.0 -15.0 -20.0
END ANTENNA-PATTERN
```

The Type Data Base2. Name Format

```
DATA-ITEM-NAME  
  <name>  
END DATA-ITEM-NAME
```

This is a simple list of names where each <name> exists in the UAN. As an example consider the following:

```
SNR-ELE-INTERACTIONS  
  abn_comdr_rx  
  intcp-b_rdr_rx  
END SNR-ELE-INTERACTIONS
```

The Type Data Base

3. One-line Format

```
DATA-ITEM-NAME <entry1> <entry2>
```

The number and form of the entries following the data item declaration will vary, the exact form and number will be apparent from the description of the appropriate data item, for example:

```
MAX-PARALLEL-TRACKS 3 (NO-UNITS)
```

4. Block Format

```
DATA-ITEM-NAME
  INPUT1 <entry1>
  INPUT2 <entry2>
END DATA-ITEM-NAME
```

The number and form of the entries varies and again the exact form will be apparent from the description of the data item. As an example consider the following data item with two inputs each being followed by a numerical value with physical units.

```
MOVER-ALTITUDE-LIMITS
  MIN-ALT 0.0 (M)
  MAX-ALT 10000.0 (M)
END MOVER-ALTITUDE LIMITS
```

5. Option Format

```
DATA-ITEM-NAME
  <option1>
  <option2>
END DATA-ITEM-NAME
```

This differs from the name format in that the entries form a list of options and are not names defined in the UAN. For example:

```
MOVE-OPTIONS
  THREAT-AVOID
END MOVE-OPTIONS
```

6. Units Used by Suppressor

Units of measurement are treated quite carefully by Suppressor, and in many cases a choice of units can be made. Units are usually recognizable by their enclosure in parentheses. In some cases units not enclosed in parentheses are given as part of the command syntax. The abbreviations and names used for the various units are as follows:

Units of Length

Label	Unit	SI equivalent	
(M)	metres	1.0	m
(KM)	kilometres	1.0	km
(FT)	feet	0.3048	m
(MILES)	statute miles	1.609344	km
(NM)	nautical miles	1.852	km
(ANGELS)	angels	304.8	m

Units of Time

Label	Unit	SI equivalent	
(MILLISEC)	milliseconds	1.0	ms
(SEC)	seconds	1.0	s
(MIN)	minutes	60.0	s
(HR)	hours	3600.0	s

Units of Speed

Label	Unit	SI equivalent	
(M/SEC)	metres per second	1.0	m s ⁻¹
(KM/HR)	kilometres per hour	0.2777	m s ⁻¹
(MPH)	miles per hour	0.4470	m s ⁻¹
(FT/SEC)	feet per second	0.3048	m s ⁻¹
(KNOTS)	knots	0.5144	m s ⁻¹
(KTS)	knots	0.5144	m s ⁻¹
(NM/HR)	knots	0.5144	m s ⁻¹

Units of Acceleration

Label	Unit	SI equivalent	
(M/SEC/SEC)	metres per second squared	1.0	m s ⁻²
(FT/SEC/SEC)	feet per second squared	0.3048	m s ⁻²

Units of Mass

Label	Unit	SI equivalent	
(KG)	kilograms	1.0	kg
(LBS)	pounds	0.4536	kg

The Type Data Base

Units of Frequency

Label	Unit	SI equivalent
(1/SEC)	cycles per second	1.0 s ⁻¹
(HZ)	hertz	1.0 Hz
(KHZ)	kilohertz	1.0 kHz
(MHZ)	megahertz	1.0 MHz
(GHZ)	gigahertz	1.0 GHz

Units of Mass Flux

Label	Unit	SI equivalent
(KG/SEC)	kilograms per second	1.0 kg s ⁻¹
(KG/HR)	kilograms per hour	3600.0 kg s ⁻¹
(LBS/HR)	pounds per hour	1632.9 kg s ⁻¹

Units of Angular Measure

Label	Unit	SI equivalent
(DEG)	degrees	0.01745 rad
(RADIANS)	radians	1.0 rad
(SR)	steradians (solid angle)	1.0 sterad

Units of Power

Label	Unit	SI equivalent
(WATTS)	watts	1.0 W

Units of Energy Flux

Label	Unit	SI equivalent
(W/M2)	watts per square metre	1.0 W m ⁻²

Units of Radiance

Label	Unit	SI equivalent
(W/SR/M2)	watts per steradian per metre squared	1.0 W sterad ⁻¹ m ⁻²

Dimensionless Units

Label	Unit
(NO-UNITS)	no units
(DB)	decibels

1.1. Player Structure

This data item defines the structure of a player type and it is required for all player-types defined in the TDB. The structure is described in terms of the component tactics, susceptibilities, capabilities, locations, elements, systems and resources which constitute each player-type. A series of phrases are entered into the TDB in a hierarchical fashion to describe each player-type, as shown below:

```
PLAYER-STRUCTURE <player-name>
  TACTIC <tactic-name>
  LOCATION <loc-id>
    ELEMENT <ele-id> <ele-name> <ele-nature> <ele-quantity>
    SUSCEPTIBILITY <susc-name>
    <SYSTEM-CATEGORY> <sys-id> <sys-name>
    CAPABILITY <capability-name>
    <RESOURCE-TYPE> <res-name> <res-nature>
      <res-amount> <res-units>
  LINKAGES
    <system-id-1> WITH <system-id-2>
END PLAYER-STRUCTURE
```

The first entry in the **PLAYER-STRUCTURE** is the <player-name> which identifies the particular player type from the list of players in the UAN. The subsequent entries are:

TACTIC <tactic-name>

A player type can have any number of sets of tactics. Associated with each set is a tactic phrase giving that set a unique name so that any player-type within the TDB can access the same tactics. The tactic name is from the list of tactics in the UAN.

LOCATION <loc-id>

A location represents a collection of elements that are in the same physical place. There is one location phrase per location block. If a player has elements in several locations then there should be a location block for each. Every player must have at least one location.

ELEMENT <ele-id> <ele-name> <ele-nature> <ele-quantity>

The first two entries are an element identifier and an element name from the list of elements in the UAN. The remaining two entries determine an element's nature, and how much of the element is on hand. <ele-nature> can be set as **DISCRETE**, which means it can be completely destroyed, or **CONTINUOUS**, which means it can never be totally destroyed. If <ele-nature> is **DISCRETE** then <ele-quantity> is a positive integer, otherwise it is a positive real number. The <ele-id> must be unique.

SUSCEPTIBILITY <susceptibility-name>

An element can have zero or more susceptibility phrases. Not having a susceptibility means the element cannot be detected by a sensor. Each phrase must include a name from the list of susceptibilities in the UAN.

The Type Data Base

Player Structure

SYSTEM <SYSTEM-CATEGORY> <sys-id> <sys-name>

If an element has no systems this phrase will be absent, otherwise there must be one phrase for each element. Firstly, it has a system category which identifies which sort of physical system the item represents. It can be one of the following:

THINKER MOVER WEAPON DISRUPTOR
SNR-RCVR SNR-XMTR COMM-RCVR COMM-XMTR

A numerical value, <sys-id>, and a system name must be associated with each system as a means of identification.

CAPABILITY <capability-name>

Each system phrase included within an element must have a minimum of one Capability Phrase. Each phrase specifies a capability name from the list of these names in the UAN.

<RESOURCE-TYPE> <res-name> <res-nature> <res-amount> <res-units>

The resource phrase can only be used for the following systems under the given conditions:

- 1) mover systems that use fuel,
- 2) weapon systems with ordnance,
- 3) weapon systems with ordnance that is modelled using future players, or
- 4) thinker systems which launch subordinates that are modelled as future players.

The following table summarises the options based on the setting of <SYSTEM-CATEGORY>:

<SYSTEM-CATEGORY>	<RESOURCE-TYPE>	<res-nature>	<res-amount>	<res-units>
MOVER	FUEL	CONTINUOUS	Positive real	(KG) or (LBS)
WEAPON	ORDNANCE	DISCRETE	Positive integer	(ROUNDS)
	FUTURE-PLAYER	DISCRETE	Positive integer	(COPIES)
THINKER	FUTURE-PLAYER	DISCRETE	Positive integer	(COPIES)

The <res-name> is defined by the user in the UAN.

LINKAGES <system-id-1> WITH <system-id-2>

This is the last phrase and is required only if the player has systems which must be explicitly linked. Each entry joins two systems identified by numbers using the word WITH. Systems that must be linked are:

- 1) sensor receivers with sensor transmitters,
- 2) communication receivers with communication transmitters,
- 3) thinkers with sensor receivers, and
- 4) weapons with tracking sensor receivers.

1.2. The Tactic Block

The tactics of each player are described in detail within the TACTIC block and can be divided into three sections: namely Co-ordination, Movement and Resource Allocation.

1.2.1. Co-ordination

Issues concerning command, control and intelligence are dealt with here. The relevant data items are:

COMM-LOSS-DECENT-TIME	INTELL-CONF-FACTOR
INTELL-REPORT-FREQ	MAX-MSG-ATTEMPTS
MAX-SNR-PERCEPTIONS	MSG-RPT-GUIDE
SENSOR-CONF-FACTOR	SNR-RPT-GUIDE
ZONE-CHARACTERISTICS	

COMM-LOSS-DECENT-TIME

One-line Format

Describes the minimum amount of time that must elapse before a decision is made to decentralize command because of loss of communication with the commander. The entries are <time>, as a positive real number, with <units> being one of (SEC), (MIN) or (HR). This data item is optional, but recommended. If it is omitted a subordinate will not assume control under any circumstances.

INTELL-CONF-FACTOR

Dimensional Format

This data item is optional and is used to provide a table of confidence and decay factors to prioritize intelligence data provided by other players. Three types of perception processed by this table are: target track, target 'identify friend or foe' (IFF) and perceived target type. These are specified with the following format:

INTELL-CONF-FACTOR	
DIMENSION 1 PLAYER-TYPE <player-type>	
DIMENSION 2 SNR-TYPE <snr-rcvr>	
DIMENSION 3 INFO-TYPE TRACK IFF TARGET-TYPE	
CONF-FACTOR	DECAY-FACTOR
<trk-conf>	<trk-decay>
CONF-FACTOR	DECAY-FACTOR
<iff-conf>	<iff-decay>
CONF-FACTOR	DECAY-FACTOR
<tgt-conf>	<tgt-decay>

where,

<player-type> occurs one or more times and is taken from the list of players in the UAN or is the keyword **DEFAULT**

The Type Data Base

Co-ordination Tactics

The second **DIMENSION** list occurs once per <player-type>, with each player having one or more named sensor receivers, where <snr-rcvr> is a name drawn from the list of such receivers in the UAN.

The third **DIMENSION** list occurs once per <snr-rcvr> and is used to specify the types of perceptions influenced by the command; these are <trk-conf>, <iff-conf>, <tgt-conf>, representing the target's track, IFF status and the target's type respectively. The confidence factors are given as a real number selected from the interval [0.0, 9.0]. Each confidence factor is subject to an exponential decay factor, given as a non-negative real number.

During the updating of a perception, the confidence factor of the incoming data is compared against a decayed confidence of the data currently stored for the perception. If the confidence of the new data is greater than or equal to that of the old perception, then the perception data will be updated. The new confidence and decay factors will then be stored along with the time at which the update took place. The default decay and confidence factors are 0.0 and 9.0 respectively, these values ensure that new data will always update existing perceptions.

INTELL-REPORT-FREQ

Dimensional Format

This data item is required if players are to report to commanders and or subordinates using **MSG-RPT-GUIDE** or **SNR-RPT-GUIDE**. The item defines how frequently a player will report to its commander or subordinate with information it has received or gathered. There is only one dimension in the format. This is the entry **CMD-CHAIN-TYPES** and it identifies the command chains from the list in the UAN. It is paired with a rate specified in the entry **RPT-RATE**, which is a positive real number from the range (0.0, 1.0] with units (1/SEC).

MAX-MSG-ATTEMPTS

One-line Format

Defines the maximum number of attempts that will be made to send a message that is not getting through to its recipient. The entry is a positive integer with (**NO-UNITS**). This data item is recommended for any player type that can talk to someone else in a situation where jamming can occur since, by default, only one attempt is made to send each message.

MAX-SNR-PERCEPTIONS

One-line Format

Defines how many locations a player type with a sensor will know about directly at any one time. The entry is a positive integer with units (**TGTS**). The default behaviour, if this data item is omitted, is that no limitation is imposed on the number of perceptions that may be held at any one time.

MSG-RPT-GUIDE

Dimensional Format

Defines which direction in a command chain a player can pass information about targets it has been told about (as opposed to having gathered the information itself). If

this data item is included then so must **INTELL-REPORT-FREQ**. There is only one dimension corresponding to the inputs:

CMD-CHAIN-TYPES identifies the command chains from the list in the UAN.

REPORT-RESPONSIBILITY determines in which direction the information can be passed. There are three choices which are:

CMDR - information is passed up to a commander,

SUB - information is passed down to subordinates, or

BOTH - information is both passed up to a commander and down to subordinates.

The following example serves as clarification:

```
MSG-RPT-GUIDE
  DIMENSION 1  CMD-CHAIN-TYPES  intell
    REPORT-RESPONSIBILITY  CMDR
END MSG-RPT-GUIDE
```

SENSOR-CONF-FACTOR

Dimensional Format

This data item is optional and is used to provide a table of confidence and decay factors to prioritize data provided by a player's own sensors. Three types of perception processed by this table are: target track, target 'identify friend or foe' IFF and perceived target type. These are specified with the following format:

```
SENSOR-CONF-FACTOR
  DIMENSION 1 SNR-TYPE <snr-rcvr> ...
  DIMENSION 2 INFO-TYPE TRACK IFF TARGET-TYPE
    CONF-FACTOR      DECAY-FACTOR
    <trk-conf>        <trk-decay>
    CONF-FACTOR      DECAY-FACTOR
    <iff-conf>        <iff-decay>
    CONF-FACTOR      DECAY-FACTOR
    <tgt-conf>        <tgt-decay>
```

where,

The first **DIMENSION** lists one or more named sensor receivers where **<snr-rcvr>** is a name drawn from the list of such receivers in the UAN.

The second **DIMENSION** list occurs once per **<snr-rcvr>** and is used to specify the relevant perceptions; these are **<trk-conf>**, **<iff-conf>**, **<tgt-conf>**, representing the target's track, IFF status and the target's type respectively. The confidence factors themselves are listed above. Each is a real number ranging from [0.0→9.0] and with each is associated an exponential decay factor given as a non-negative real number.

During the updating of a perception, the confidence factor of the incoming data is compared against a decayed confidence of the data currently stored for the perception. If the confidence of the new data is greater than or equal to the old perception, then the perception data will be updated. The new confidence and decay factors will then be

The Type Data Base

Co-ordination Tactics

stored in the perception as well as the time at which the update took place. The default decay and confidence factors are 0.0 and 9.0 respectively, this will cause new data to always update existing perceptions.

SNR-RPT-GUIDEDimensional Format

Defines which direction in a command chain a player can pass information about targets it has detected itself, using its own sensors. If this entry is used then so should **INTELL-REPORT-FREQ**. There is one more entry than the corresponding **MSG-RPT-GUIDE** item. The allowable entries are:

COMMAND-CHAIN-TYPES the name of the command chains from the list in the UAN,

SNR-TYPE the name of the sensor from the list of sensor-receivers in the UAN, and

REPORT-RESPONSIBILITY which determines in which directions data received from each sensor can be reported. As with **MSG-RPT-GUIDE** these are one of the three options:

CMDR - information is passed up to a commander,

SUB - information is passed down to subordinates, or

BOTH - information is both passed up to a commander and down to subordinates.

ZONE-CHARACTERISTICSDimensional Format

Defines which player types are allowed to report their observations. To whom they report is set by **MSG-RPT-GUIDE** and **SNR-RPT-GUIDE**. The format is one dimensional with two inputs:

ZONE-TYPE where the list of names of the zone to which permission applies is specified. These names are taken from the list of zones in the UAN

ZONE-PERMISSION occurs once for each zone-name linking the permissions to the zones. There are two choices of setting:

MSG-RPT-OK this gives permission for targets to be reported to commanders based on message reporting guidelines

SNR-RPT-OK this gives permission for targets to be reported to commanders based on sensor reporting guidelines.

If this data item is omitted a player will not be allowed to report observations as the default value is no.

1.2.2. Movement

Movement is subdivided into the following categories and below each is listed the data items that are relevant to each type of movement.

Reactive Movement:

ACCELERATION-MODE	ATK-PRIORITIES
INTERCEPT-MODE	MOVE-PLANS
MOVE-TO-ENG	PLAN-ASPECT
PLAN-PATTERNS	PLAN-PROFILE
PURSUIT-MODEL-OFFSET	REVECTOR-DIST-THRESH

Launch:

LAUNCH-CMD-CHAIN

TF/TA/TA (Terrain Following/Terrain Avoidance/Threat Avoidance)

LOOK-AHEAD-DISTANCE	MOVE-OPTIONS
THREAT-VOLUME	

Reactive Movement**ACCELERATION-MODE**One-line Format

Specifies the type of acceleration to be used when moving between points of a flight path. There is only one entry after the data item title and that can be either:

UNIFORM, any change in speed between two flight path points will be linear across the entire distance between points.

MAXIMUM, accelerates or decelerates the player using the **MAX-ACCELERATION** until the desired speed, defined at the next point, is reached. Any distance remaining is travelled at the new speed.

If this data item is omitted the default is **UNIFORM**.

ATK-PRIORITIESDimensional Format

Defines classes of targets. It is a one dimensional format with two inputs:

LIST-NAME where the name of the class of targetable elements is entered from the list of manoeuvres in the UAN. This list of names occurs only once.

TGT-ELEMENTS occurs once for each class name above in the corresponding order. The entries, after the **TGT-ELEMENTS** name, are the names of the associated elements from the list in the UAN

This data item is used in conjunction with **MOVE-PLANS** and associates target's element names with the names of manoeuvres in the UAN so that these names can be used in these plans.

INTERCEPT-MODEOne-line Format

Defines the intercept mode for a mover to use in attacking a target. There is only one entry and it is either:

The Type Data Base

Movement Tactics

PREDICTED, the intercept route considers the heading and velocity of the target, and the resulting attack approximates a straight line towards the predicted intercept point

PURSUIT the intercept route is toward the current target position resulting in the mover falling in behind the target.

This is an optional data item and if omitted **PREDICTED** is the default.

MOVE-PLANS

Block Format

These represent the contingency plans that might come into play when a player location moves in reaction to a stimulus. This data item is used in conjunction with **ATK-PRIORITIES**, **PLAN-PROFILE**, **PLAN-PATTERNS** and **PLAN-ASPECT** in the TDB and **PATH** or **PLANS-FOR-MOVEMENT** in the SDB. The format of **MOVE-PLANS** consists of one or more Plan Sentences, where each sentence describes a particular plan, as shown below:

```
MOVE-PLANS
  PLAN <plan-name> (...<plan-argument> ...)
    {Action Statement} or {Conditional Structure} or 'nothing'
  END-PLAN
.
.
.
END MOVE-PLANS
```

Each plan has a <plan-name>, an optional <plan-argument> and a body describing what the player location does once the plan comes into effect.

<plan-name> identifies each plan from the list of manoeuvres in the UAN.

<plan-argument> is also from the list of manoeuvres in the UAN and serves as an alias for an actual manoeuvre which is defined within the TDB. The identification of the argument with its alias is accomplished within the SDB so that many different arguments may be passed to the same plan, giving great flexibility in the use of the plan. A <plan-argument> may occur zero or more times in the plan's argument list and if present this list is enclosed by parentheses with all individual arguments must be surrounded by spaces. If no <plan-argument> is present there is no argument list and therefore no parentheses are needed. The plan's actions are achieved via the {Action Statement} or a {Conditional Structure}. The Action Statement is used if the location carries out an action unconditionally. The Conditional Structure is used if the actions of the player locations are based on some criterion.

Action Statement

When an Action Statement is used it has the following format:

<p><action> ... AND <action> ...</p>
--

<action> occurs one or more times, with the keyword **AND** used to connect phrases, and is one of the following:

NOW-USE-PROFILE <profile-name>

<profile-name> is either a <plan-argument> serving as an alias for a **PLAN-PROFILE** defined in the TDB or is the name of such a **PLAN-PROFILE** declared in the UAN. This entry causes a player location to perform a vertical manoeuvre which is described in a **PLAN-PROFILE** data item.

NOW-USE-PATTERN <pattern-name> {using-phrase}

<pattern-name> is either a <plan-argument> serving as an alias for a **PLAN-PATTERNS** data item, defined in the TDB, or is the name of such a **PLAN-PATTERNS** item declared in the UAN. This entry causes a player location to perform a three dimensional manoeuvre which is described in the relevant **PLAN-PATTERNS** data item. The {using-phrase} is optional and can be used to align the pattern with the mover's current heading, or to cause the mover's sensors to be turned on or off during a manoeuvre. The {using-phrase} for changing sensor states has the following syntax:

USING TURN <state> <sensor-id> <sensor-name> **DURING**
<maneuver>

where,

<state> is either **ON** or **OFF**,

<sensor-id> is the system identification number of the sensor,

<sensor-name> is the sensor's name drawn from the UAN, and

<maneuver> is any one of: **CLIMB**, **CLIMB/DIVE**, **DIVE**, **CLIMB/TURN**, **TURN**, **DIVE/TURN** and **CLIMB/DIVE/TURN**.

The {using-phrase} can also be used to rotate the whole pattern so that the heading of the mover does not change as it begins the pattern. This is accomplished with the phrase:

USING REL-HEADING

EXECUTE PLAN <plan-name> (...<argument>...)

<plan-name> is either a <plan-argument> alias for or the actual name of a **MOVE-PLANS** plan declared in the UAN. The <argument> occurs zero or more times, if present then all such arguments are enclosed in parentheses and surrounded by spaces; each <argument> is itself either a <plan-argument> or the name of a manoeuvre from the UAN. The <argument> serves as a <plan-argument> for the invoked **MOVE-PLANS** plan, <plan-name>.

This entry allows a player to dynamically change plans. The plan to be executed can be the same plan as the plan currently being executed, i.e. plan's can be called recursively. The use of arguments allows the plans to receive, pass and use additional data which can be flexibly defined within the SDB.

The Type Data Base

Movement Tactics

EXECUTE SDB-PLAN AT-CHECKPOINT

This action allows a player to return to its planned path as defined in the SDB. This action must be preceded by a **GOTO POINT** <point-name> command. When the named checkpoint is reached, the SDB path is resumed.

GOTO POINT <point-name>

This entry causes the player executing the action to go to a certain point. The <point-name> is either a checkpoint name included in an SDB **PATH** or **PLANS-FOR-MOVEMENT** data item or an argument that refers to the checkpoint.

GOTO POSITION TGT

This entry has two different meanings. If it is used in conjunction with **PLAN-PROFILE** the entry causes a player to move towards the position of the target following the route defined in the **PLAN-PROFILE**. If no **PLAN-PROFILE** is given then the player will simply move directly towards the current position of the target.

EXECUTE SUSPEND MOVEMENT

This entry causes a mover to suspend its movement, in anticipation of resuming at a later time. When used in conjunction with **NOW-USE PROFILE**, the movement will be suspended after the last profile point. When used with **GOTO POINT** or **GOTO POSITION TGT**, the movement will be suspended after reaching the indicated point. Finally, if neither **PROFILE** nor **POINT** are specified, movement will be suspended immediately.

FOCUS-ON PRIORITY <priority-name>

<priority-name> is either a <plan-argument> serving as an alias for an **ATK-PRIORITIES** target class defined in the TDB or is the name of such an **ATK-PRIORITIES** target class declared in the UAN. This entry causes a player to select a class of targets to attack.

NOW TERRAIN-FOLLOW-AT

<alt-value> <alt-units> ORIGINAL-ALTITUDE

These entries are used in combination to specify the altitude above ground level at which the player should fly. <alt-value> is a real number with <alt-units> chosen from (M), (KM), (FT), (MILES) or (NM). The **ORIGINAL-ALTITUDE** option is used to return to the altitude specified in the **BOUNDARY** input item in the SDB.

NOW STOP TERRAIN-FOLLOW

This item causes a mover to immediately cease terrain following, regardless of the entries in the **MOVE-OPTIONS** table in the TDB tactic block.

NOW EVALUATE-AFTER <t-value> <t-units>

This item causes the player to wake-up after a specified amount of time has elapsed in order to evaluate the conditions of the current plan. It should only be used to evaluate those plans executed while *not* attacking a target. Periodic reviews of such things as **FUEL-REMAINING** can be scheduled by invoking this action. Wake-ups scheduled by this data item will evaluate the plan current at the time of the wake-up, which will not necessarily be the same plan that

scheduled the wake-up. <t-value> is a real number with <t-units> drawn from either (SEC), (MIN) or (HR).

NOW PRINT NEW-PATH

This item will print the current flight path in the model output listing, it is useful for monitoring the progress of a player through its manoeuvres.

NOW-USE INTERCEPT-MODE <i-mode> {**WITH-OFFSET** <off-value> <off-units>}

This item will dynamically change the intercept mode used when attacking a target and when the intercept mode is changed to **PURSUIT**, an offset may be specified. <i-mode> is either **PREDICTED** or **PURSUIT**. <off-value> is a real number with <off-units> of (M), (KM), (FT), (MILES) or (NM). Use of this item will override values specified in the TDB.

NOW-USE ASPECT <aspect-name>

<aspect-name> is either a <plan-argument> serving as an alias for a **PLAN-ASPECT** defined in the TDB or is the name of such a **PLAN-ASPECT** declared in the UAN. This item will make the mover follow the route defined in the specified aspect pattern in the **PLAN-ASPECT** table in the TDB. Note that in the actions above where the use of a **PLAN-PROFILE** has been referred to, a **PLAN-ASPECT** may be substituted for the **PLAN-PROFILE**.

Conditional Structure

A 'Conditional Structure' is used whenever any actions are contingent on selected criteria. It is composed of conditional statements, which in turn define a set of one or more criteria, and an action that will be carried out if these criteria are true. The conditional structure can include three types of conditional statement, **WHEN**, **BUT-WHEN**, and **OTHERWISE** used in the following format:

```
WHEN (Condition Expression)
  (Action Statement) or (Then Statement)
.
.
.
BUT-WHEN (Condition Expression)
  (Action Statement) or (Then Statement)
.
.
.
OTHERWISE
  (Action Statement)
```

The **WHEN** statement must occur exactly once, the **BUT-WHEN** statement occurs zero or more times and the **OTHERWISE** statement occurs zero or once. The (Action Statement) has been described above. The (Then Statement) expands the

The Type Data Base

Movement Tactics

capabilities of any of the conditional statements by allowing them to contain further nested conditional expressions and has the following format:

```
THEN:
  {Conditional Expression}
END-THEN
```

The (Condition Expression) occurs exactly once in the places indicated in the above format statement and describes a condition to be tested with the following format:

```
<condition>
... AND <condition> ...
```

NB: Only one (Condition Expression) can occur at a time, but it can contain more than one condition combined with the **AND** connector. Each <condition> is either an equivalence entry or a threshold entry. Equivalence entries test equality between the conditions and threshold entries test a dynamic condition by comparing a continuous variable with a some specific threshold value. The options for each entry are listed in the table below. Following the table is a detailed explanation of the form of each entry.

Equivalence Entries	Threshold Entries	
BEEN-ASSIGNED PERCEPTION-SOURCE SNR-STATUS TGT-TYPE <argument-name> 3D-TGT-LOC	AVAILABLE-RESOURCE ELEV-ANGLE-TO-TGT FUEL-REMAINING HDG-CROSS-ANGLE LAST-SENSED MY-ALT MY-HDG MY-SPD REL-SUB-HDG REL-TGT-ALT REL-TGT-HDG TGT-ALT TGT-ASPECT-ANGLE	TGT-HDG TGT-SPD TIME-LAPSE TIME-SEPARATION TOTAL-TARGETS TOTAL-TIME 2D-CLOSING-SPD 2D-DIST-TO-INT 2D-DIST-TO-TGT 2D-REL-TGT-OFFSET 2D-REL-TGT-UP/DOWNRNG 3D-DIST-TO-TGT

Equivalence Entries

These conditions test for absolute equality in the criterion.

BEEN-ASSIGNED

This entry tests if the current target has been assigned to this player by the commander. NB: a player disaggregated from a weapon is automatically assigned to the target at which the weapon fired. The options are:

IS	YES
IS-NOT	NO

PERCEPTION-SOURCE

This entry tests the source of the target perception. The options are:

IS	DIRECT-INTELL
IS-NOT	INDIRECT-INTELL
	<sensor-receiver>
	<player-type>

IS DIRECT-INTELL implies that the moving player is actually sensing the target with its own sensor and IS INDIRECT-INTELL implies that the moving player has received intelligence from another player about the target. The values <snr-type> and <player-type> are from the lists of sensor receivers and players in the UAN, and specify a particular source of the direct or indirect intelligence.

SNR-STATUS

There are two options here:

SNR-STATUS IS	DETECT
	LOSE-DETECT

SNR-STATUS IS DETECT is true when a target is a candidate for a lethal engagement or a lethal engagement is proceeding against the target; SNR-STATUS IS LOSE DETECT is true if a lethal engagement is being cancelled for the target or if the target is not a candidate for a lethal engagement. For this condition to work correctly a LETHAL-ENGAGEMENT block of tactics must be present in the player's RESOURCE-ALLOCATION entry in the TDB.

TGT-TYPE

This entry compares the target currently being considered with a specific element name. The options are:

IS	<element-name>
IS-NOT	

The Type Data Base

Movement Tactics

<argument-name>

This entry compares the actual value of an argument in the Plan Sentence with a specified value. The format is:

<argument-name>	IS IS-NOT	<argument-value>
-----------------	--------------	------------------

Both the <argument-name> and the <argument-value> are taken from the list of manoeuvres in the UAN.

3D-TGT-LOC

This entry determines whether the target location is within a particular zone associated with the mover's location. The options are:

WITHIN OUTSIDE	<zone-name>
-------------------	-------------

<zone-name> is from the list of zones in the UAN.

Threshold Entries

These conditions test the relationship between the dynamic condition being tested and the value of a specific threshold. In the following descriptions <real> refers to a real number and <positive-real> to a positive real number respectively.

AVAILABLE-RESOURCE the quantity of ordnance of a particular type that is remaining
The options are:

>	<positive-real>	ROUNDS
<		

with qualifier:

RE:	<ordnance-name>	ORDNANCE
	ALL	

The value <ordnance-type> is from the list of ordnance in the UAN.

ELEV-ANGLE-TO-TGT the elevation angle subtended by the target referred to the pitch angle of the mover.

HDG-CROSS-ANGLE the heading of the target relative to the heading of the mover.

MY-HDG the heading of the mover.

REL-SUB-HDG the angle between the heading of the mover and the range vector drawn from the mover to the target.

REL-TGT-HDG the angle between the heading of the target and the range vector drawn from the target to the mover.

TGT-HDG the heading of the target.

The options for the above six entries are:

>	<real>	(RADIANS)
<		(DEG)

Heading is measured anti-clockwise from due east in the range $[-\pi \rightarrow \pi]$ or $[-180^\circ \rightarrow 180^\circ]$.

FUEL-REMAINING the amount of fuel left.

The options are:

>	<positive-real>	(LBS)
<		(KG)

The Type Data Base

Movement Tactics

LAST-SENSED the time elapsed since the last sensory perception of the target.

TIME-LAPSE the time elapsed since either a repeating pattern was begun or the mover motion was suspended.

TIME-SEPARATION the expected time remaining before the mover intercepts the target.

TOTAL-TIME the time elapsed since a mover first started to move.

The options for the above four entries are:

>	<positive-real>	(SEC)
<		(MIN)
		(HR)

MY-ALT The altitude above mean sea level of the mover.

TGT-ALT The altitude above mean sea level of the target.

The options for the two above entries are:

>	<real>	(M) (MILES)
<		(KM) (ANGELS)
		(FT) (NM)

MY-SPD The speed of the mover.

TGT-SPD The speed of the target.

2D-CLOSING-SPD the relative ground speed of the mover and the target projected along their range vector. It is positive when they are approaching and negative when receding.

The options for the above three entries are:

>	<real>	(M/SEC) (MPH)
<		(KM/HR) (FT/SEC)
		(NM/HR) (KTS)
		(KNOTS)

The speed may be zero if a mover has not yet started to move.

REL-TGT-ALT how much higher the target is than the resource or mover

2D-REL-TGT-UP/DOWN-RNG the distance of the mover from the projected point of closest approach of the target to the current position of the mover. When the mover is approaching this point, the range will be positive; when receding the range will be negative.

REL-TGT-ALT is the target's altitude relative to that of the mover. The options for the above three entries are:

>	<real>	(M) (MILES)
<		(KM) (FT) (NM)

2D-DIST-TO-INT the ground distance to the computed intercept point of the mover and target.

2D-DIST-TO-TGT the ground distance between the mover and target.

2D-REL-TGT-OFFSET the distance of the target from the projected point of closest approach of the target to the current position of the mover. When the target is approaching this point the range will be positive; when receding the range will be negative.

3D-DIST-TO-TGT the true distance between the mover and the target.

The options for the above four entries are:

>	<positive-real>	(M) (MILES)
<		(KM) (FT) (NM)

TGT-ASPECT-ANGLE target aspect is the angle formed by the line of sight from the mover location to the target and the aft longitudinal axis of the target. (That is to say the vector pointing in the opposite direction to the target's heading.) The options are:

>	<real>	(RADIANS)	LEFT
<		(DEG)	RIGHT
			ABS

The directions **LEFT** and **RIGHT** are with respect to the target whilst the keyword **ABS** implies that the direction can be neglected. The range of possible values for the angles are either $[0^\circ \rightarrow 180^\circ]$ or $[0.0 \rightarrow \pi]$.

TOTAL-TARGETS The total number of known targets.

The options are:

>	<positive-real>	TGTS
<		

with qualifiers:

RE:	<player-name>	TGT-TYPE
	ANY	
RE:	<zone-name>	ZONE
	ANY	

The second qualifier is optional.

MOVE-TO-ENG

One-line Format

Specifies whether a player can move to lethally engage a target. There is one entry following the data item name and this can be either **YES** or **NO**. For example this would be set to **YES** for players that would engage in air-to-air combat, or aircraft that would

The Type Data Base

Movement Tactics

manoeuvre to attack a ground site. Sites that are stationary and movers that follow a predetermined path would have this set to NO.

PLAN-ASPECTDimensional Format

Describes the path to be followed by an attacking aircraft defined in terms of the target's aspect angles and ranges. These patterns are invoked in movement plans. This data item is required only if the **NOW-USE ASPECT** action item is present in the player's **MOVE-PLAN**. The format has a single dimension which consists of **ASPECT-TYPE** followed by a list of <aspect-name>'s from the list of manoeuvres in the UAN. This is followed by a header line for a table. Each table begins with a header, which may be continued on more than one line. Each point data entry represents a way-point in the manoeuvre, and describes the player's position, speed and minimum turn radius at that point. The header's component labels are defined in the table below:

Label	Allowed units	Input	Comment	Form of Entry
ANGLE	(RADIANS) (DEG)	<angle>	The target's aspect angle	real number between [0°→180°] and [0→π]
DIR		<direction>	The sense of the target's aspect angle	LEFT or RIGHT
DIST	(M) (KM) (FT) (NM) (MILES)	<distance>	The distance from the target	non-negative real number
Z	(M) (KM) (FT) (NM) (MILES)	<z-loc>	The altitude of the mover	real number
Z-REF		<z-ref>	The reference frame for the altitude	AGL , MSL , REL/CURR or REL/TGT
SPD	(M/SEC) (KM/HR) (FT/SEC) (MPH)	<speed>	The mover's speed at each way-point	real number
SPD-REF		<speed-ref>	The reference frame for the speed	ABS , REL/CURR or REL/TGT
TURN-RADIUS	(M) (KM) (FT) (NM) (MILES)	<radius>	The minimum turn radius of the mover at the current speed	non-negative real number

The following example shows the format of the table, with its header line and point data entries:

ANGLE (DEG)	DIR	DIST (KM)	Z (M)	Z-REF	SPD (MPH)	SPD-REF	TURN- RADIUS (M)
45.0	LEFT	6.0	1000.0	REL/TGT	100.0	REL/TGT	1900.0
30.0	LEFT	3.0	500.0	REL/TGT	100.0	REL/TGT	1900.0
10.0	LEFT	1.0	100.0	REL/TGT	100.0	REL/TGT	1900.0

Note that the units used in defining the way-points are identified in the header, so that all way-points must use the same units. The references have the following meanings: **AGL** is above ground level, **MSL** is mean sea level, **REL/CURR** is relative to the current altitude or speed of the mover and **REL/TGT** is relative to the current altitude or speed of the target.

The Type Data Base

Movement Tactics

PLAN-PATTERNSDimensional Format

This describes three dimensional manoeuvres used in movement plans. Unlike **PLAN-ASPECT** and **PLAN-PROFILES** a **PLAN-PATTERN** is not defined in terms of a target's location but rather in terms of fixed co-ordinates in the scenario. It is therefore useful for putting players into holding patterns or to give them arbitrary manoeuvres around arbitrary points. A player location will start from some specified point and either enter a repeating or a non-repeating manoeuvre with the starting point relative to a point in the path. Plan patterns should only be included if a player type has patterns mentioned in a **MOVE-PLANS** data item. The format has a single dimension which consists of **PATTERN-TYPE** followed by a list of <pattern-name>'s from the list of manoeuvres in the UAN. This is followed by a header line for a table. Each table begins with a header, which may be continued on more than one line. Each point data entry represents a way-point in the manoeuvre, and describes the player's position, speed and minimum turn radius at that point. The header's component labels are defined in the table below:

Label	Allowed Units	Form of Input	Comment	Form of Entry
X	(M) (KM) (FT) (NM) or (MILES)	<x-loc>	Mover's x-coordinate relative to starting point	real number
Y	(M) (KM) (FT) (NM) or (MILES)	<y-loc>	Mover's y-coordinate relative to starting point	real number
Z	(M) (KM) (FT) (NM) or (MILES)	<z-loc>	The altitude of the mover	real number
REF		<ref>	The reference frame for the altitude	AGL, MSL, REL/CURR or REL/TGT
SPD	(M/SEC) (KM/HR) (FT/SEC) or (MPH)	<speed>	The mover's speed at each way-point	positive real number
SPD-REF¹		<ref>	The reference frame for the speed	ABS, REL/CURR or REL/TGT
TURN-RADIUS	(M) (KM) (FT) (NM) or (MILES)	<turn-rad>	radius of any implemented turn	positive real number
DIR		<direction>	A direction for the movement	RIGHT, LEFT, STRAIGHT, STOP or SHORTER

¹ **SPD-REF** is an optional entry which can be completely omitted. In this case all speeds are absolute, so that this is equivalent to having used **ABS** for all entries.

The following example shows the format of the table, with its header line and point data entries:

PLAN-PATTERNS							
DIMENSION 1 PATTERN-TYPE racetrack							
X (KM)	Y (KM)	Z (M)	REF	SPD (M/SEC)	TURN-RADIUS (M)	DIR	
0.0	0.0	9000.0	MSL	175.0	4500.0	RIGHT	
0.0	100.0	9000.0	MSL	175.0	4500.0	RIGHT	
40.0	100.0	9000.0	MSL	175.0	4500.0	RIGHT	
40.0	0.0	9000.0	MSL	175.0	4500.0	RIGHT	
END PLAN-PATTERNS							

This example is of a repeating manoeuvre whose origin coincides with the first point on the path, i.e. the position of the mover when the pattern was begun.

Note that the units used in defining the way-points are identified in the header, so that all way-points must use the same units. The references have the following meanings: **AGL** is above ground level, **MSL** is mean sea level, **REL/CURR** is relative to the current altitude or speed of the mover and **REL/TGT** is relative to the current altitude or speed of the target. The 'directional' keywords which form the last entry of each way-point can either indicate the sense of a turn, i.e. **RIGHT** or **LEFT**, or that the mover continues in a straight line without turning, **STRAIGHT** or they can be used in a different sense entirely to indicate if a manoeuvre repeats or not. In this case a final entry of **STRAIGHT** or **STOP** indicates that the pattern is non-repeating and the deprecated keyword **SHORTER** indicates that it repeats. (Use **RIGHT**, **LEFT** or **STRAIGHT** instead.)

The Type Data Base

Movement Tactics

PLAN-PROFILEDimensional Format

Describes the path to be followed by an attacking aircraft defined in terms of the target's range and altitude. This data item is required only if the **NOW-USE PROFILE** action item is present in the player's **MOVE-PLAN**. This data item provides alternate altitude/speed modes of travel by which a player location with a specific weapon type, can approach a specific target. This is based on the distance from the target. The format is three dimensional corresponding to **PROFILE-NAME**, **2D-DIST-REL-TGT** and **ALT-REL-TGT**. These entries are summarized in the following table:

DIMENSION	List Name	Form of Entries	Description
1	PROFILE-NAME	<profile-name>	The profile names are drawn from the UAN's list of manoeuvres
2	2D-DIST-REL-TGT	<2D-units> <2D-distance>	(M), (KM), (FT), (MILES) or (NM) Two or more non-negative real numbers in ascending order
3	ALT-REL-TGT	<alt-rel-units> <altitude-rel>	(M), (KM), (FT), (MILES) or (ANGELS) Two or more real numbers in ascending order.

An example with a single <profile-name> 'air_intercept_profile' is:

```

PLAN-PROFILE
  DIMENSION 1 PROFILE-NAME air_intercept_profile
  DIMENSION 2 2D-DIST-REL-TGT (KM) 0.0 5.0 10.0 30.0 100.0
  DIMENSION 3 ALT-REL-TGT (KM) -5.0 -1.0 0.5 5.0
    DIST (KM) ALTITUDE (M) SPD (M/SEC) REF TURN-RADIUS (M)
      12.0 -1000.0 275.0 REL/TGT 1900.0
      0.0 5.0 275.0 REL/TGT 1900.0
      -9.0 500.0 265.0 REL/TGT 1900.0
    DIST (KM) ALTITUDE (M) SPD (M/SEC) REF TURN-RADIUS (M)
      15.0 400.0 275.0 REL/TGT 1900.0
      0.0 0.0 275.0 REL/TGT 1900.0
      -9.0 250.0 270.0 REL/TGT 1900.0
    DIST (KM) ALTITUDE (M) SPD (M/SEC) REF TURN-RADIUS (M)
      12.0 500.0 275.0 REL/TGT 1900.0
      0.0 5.0 275.0 REL/TGT 1900.0
      -9.0 200.0 285.0 REL/TGT 1900.0
  DIMENSION 3 ALT-REL-TGT (KM) -5.0 -1.0 0.5 5.0
    <Omitted specification for range 5 to 10 km>
  DIMENSION 3 ALT-REL-TGT (KM) -5.0 5.0
    <Omitted specification for range 10 to 30 km>
  DIMENSION 3 ALT-REL-TGT (KM) -5.0 5.0
    <Omitted specification for range 30 to 100 km>
END PLAN-PROFILE

```

Each profile is labelled by a header whose components describe the individual items in each of the 'point data entries' which constitute the body of the table. Each point data entry represents a way-point in the manoeuvre, and describes the player's position, speed and minimum turn radius at that point. The header's component labels are defined in the following table:

Label	Units	Description of entry
DIST	(M) (KM) (FT) (MILES)	Distance to target
ALTITUDE	(M) (KM) (FT) (MILES) (ANGELS)	Mover's altitude
SPD	(M/SEC) (KM/HR) (FT/SEC) (MPH)	Mover's speed
REF	MSL AGL REL/TGT REL/CURR	Reference frame for the altitude
SPD-REF ²	ABS REL/CURR REL/TGT	Reference frame for the speed
TURN-RADIUS	(M) (KM) (FT) (MILES)	Minimum turn-radius of mover at current speed

Note that the units used in defining the way-points are identified in the header, so that all way-points must use the same units. The references have the following meanings: **AGL** is above ground level, **MSL** is mean sea level, **REL/CURR** is relative to the current altitude or speed of the mover and **REL/TGT** is relative to the current altitude or speed of the target. The **SPD-REF** entry is optional and can be omitted, but clearly if it is it must be omitted for all the way-points. The default value of the **SPD-REF** entry is that the speeds are in absolute units of measure, **ABS**.

PURSUIT-MODE-OFFSET

One-line Format

When **INTERCEPT-MODE** is set to **PURSUIT** this data item defines an intercept point by specifying a point which is either offset to lag behind or lead ahead of the target. Two entries follow the name of the data item, a real number along with its units which are one of (M), (KM), (FT), (MILES) or (NM). If this item is omitted the default offset is zero which corresponds to the intercept point being the target's position.

REVECTOR-DIST-THRESH

Dimensional Format

Defines the propensity of a player to change its path based on a change of the intercept point of a target it is attempting to intercept. The aim of this data item is to smooth out the movement path. The format has only one dimension corresponding to the inputs:

2D-DIST-REL-INT followed by <d-units> which can be (M), (KM), (FT) or (MILES) then two or more non-negative real numbers are input in ascending order specifying distances.

² **SPD-REF** is an optional entry which can be completely omitted. In this case all speeds are absolute, so that this is equivalent to having used **ABS** for all entries.

The Type Data Base

Movement Tactics

INTERCEPT-CHANGE followed by <t-units> which can be (M), (KM), (FT) or (MILES) then a positive real number occurs one time for each distance interval specifying a <threshold>.

This is an optional data item, but if omitted a player may manoeuvre more than is necessary. N.B: <d-units> and <t-units> do not have to be the same.

Launch**LAUNCH-CMD-CHAIN**Name Format

Defines the command chain used in decisions about launching subordinates. This command chain must be named in the UAN. There is no default for this data item, so, if it is missing no launching of subordinates can occur.

Terrain Following, Terrain Avoidance and Threat Avoidance**LOOK-AHEAD-DISTANCE**One-line Format

This is required for any player that can perform terrain following. It represents the distance ahead that a player can see when deciding to climb or dive in order to avoid terrain. The distance is entered as a positive real number with units as (M), (KM), (FT) or (MILES).

MOVE-OPTIONSOption Format

Defines movement options. There are four options to choose from:

TERRAIN-FOLLOW - attempting to maintain a given altitude above ground level by changing direction in the vertical plane. **LOOK-AHEAD-DISTANCE** must be specified,

TERRAIN-AVOID - avoiding terrain by changing direction in the horizontal plane but staying within an upper and lower band of altitude,

THREAT-AVOID - avoiding a threat by flying around it, keeping a specified horizontal distance from the threat, or

NONE.

Any meaningful combination of these options may be specified. Note that if **NONE** is specified then no other values are allowed.

THREAT - VOLUME

Dimensional Format

This defines the sizes of the volumes around perceived threats. Each threat must have an associated **TOLD ABOUT** data item entry in the SDB and together these define the site which should be avoided. The format is a list employing three **DIMENSION** statements as summarised below:

Dim	Dimension Name	Input	Unit Options	
1	PLAYER-TYPE	<threat-name>		<threat-name> occurs one or more times from the list of players in the UAN.
2	ALT	<alt-units> <altitude>	(M) (KM) (FT) (MILES) or (ANGELS)	<altitude> is a real number occurring two or more times in ascending order.
3	RNG	<rng-units> <range>	(M) (KM) (FT) or (MILES)	<range> is a non-negative real number occurring two or more times in ascending order starting with 0.0.
	PRIORITY	(NO-UNITS) <priority>		<priority>

The Type Data Base

Resource Allocation

1.2.3. Resource Allocation

The purpose of this data item is to allocate a player's resources in response to the current tactical situation.. First the data items which work in conjunction with resource allocation are described. Note that the first two are required entries:

ASG-CMD-CHAIN

EVALUATION-RATES

SALVO-FIRING

ASG-CMD-CHAIN

One-line Format

This identifies the command chain from which a player will receive assignments from its commander. The name of the command chain is the only entry and is from the list of command chains in the UAN.

EVALUATION-RATES

Block Format

This is a required entry for a player who can make assignments, engage targets lethally or non-lethally, or launch resources. It defines how often a player will think about taking any of these actions. There are seven entries and only the entries that relate to the tactics that a player possesses should be specified. If an entry is omitted that thinker will not be able to make decisions relating to that activity. Each entry is followed by an evaluation rate specified using a positive real number less than 1.0 with units of (1/SEC). The entries are:

ASG-EVAL-RATE defines the minimum amount of time that can elapse between two lethal assignment considerations for any given target,

ASG-TGT-UPDATE-RATE limits how often a commander will update a subordinate about the status of a target that it has been lethally assigned to,

EMCON-EVAL-RATE defines the minimum amount of time that can elapse between two decisions to turn a sensor on or off,

ENG-EVAL-RATE defines the minimum amount of time that will elapse between successive lethal engagement consideration for any given target,

FREE/TIGHT-EVAL-RATE defines the maximum rate at which a commander will evaluate whether or not to change the lethal mode of control of its subordinates,

JAM-EVAL-RATE defines how often a player will think about using disruptor systems, and **LAUNCH-EVAL-RATE** defines how often a player will think about launching its subordinates.

SALVO-FIRING

Dimensional Format

Defines the number of shots a player will take at a single target as a function of the target's relative velocity and of how many shots have already been fired. The number of shots taken can depend on whether the target is approaching or receding. It is recommended that the **WITH-SALVO-FIRING** qualifier in the **LETHAL-ENGAGE-FIRING-START** procedure of **RESOURCE ALLOCATION** is used instead of this data item. The format for the input is as follows:


```

SALVO-FIRING
  DIMENSION 1 TGT-MOTION APPROACHING RECEDING
    ROUNDS-FIRED (ROUNDS)  4  2  2
    ROUNDS-FIRED (ROUNDS)  2  1
END SALVO-FIRING

```

The **ROUNDS-FIRED** entries specify both the number of salvos and the number of shots that can be fired in each salvo at approaching and receding targets respectively. In this example, a maximum of three salvos can be fired at approaching targets and two at receding targets. In the case of a target that is always approaching one salvo of four shots, followed by two more of two shots each can be taken. If the target were to pass by and begin to recede after the second salvo no further shots could be taken, since only two salvos can be attempted against receding targets and this limit would already have been reached.

Resource Allocation Procedures

The purpose of this data item is to allocate a player's resources in response to various situations. It consists of nineteen possible procedures which fall into one of six functional groups which are summarised in the following table:

Functional Group	Description	Procedure Names
Lethal Assignment	Player type has subordinates to which it can make lethal assignments	LETHAL-ASSIGNMENT-QUEUE-ADD LETHAL-ASSIGNMENT-QUEUE-DROP LETHAL-ASSIGNMENT-START LETHAL-ASSIGNMENT-STOP
Lethal Engagement	Player type has weapons to carry out lethal engagements	LETHAL-ENGAGE-QUEUE-ADD LETHAL-ENGAGE-QUEUE-DROP LETHAL-ENGAGE-START LETHAL-ENGAGE-STOP LETHAL-ENGAGE-FIRING-START LETHAL-ENGAGE-FIRING-STOP
Non-Lethal Engagement	Player type has disruptors that can reactively jam communication or sensor receivers	JAMMER-QUEUE-ADD JAMMER-QUEUE-DROP JAMMER-SPOT-ADD JAMMER-SPOT-DROP
Movement	Player type has subordinates that can be launched	LAUNCH-START
Emission Control	Player type has sensors which it can turn on or off	EMCON/TURN-ON EMCON/TURN-OFF
Change Lethal Mode of Control	Player type has subordinates to which it can send changes in the lethal engagement mode of control	GUNS-FREE GUNS-TIGHT

The format for **RESOURCE-ALLOCATION** is shown below. Each procedure is enclosed in a block which is delimited by the entries **procedure-name** and **END procedure-**

The Type Data Base

Resource Allocation

name. The procedures consists of one or more target paragraphs and each paragraph being made up of a 'Target Paragraph Identifier', 'Filtering Sentences' and 'Selection Sentences'. The precise content of each block differs from procedure to procedure, but what follows is a description of the format for all procedures.

```

RESOURCE ALLOCATION
<procedure-name>
  TGT-TYPE <name-option>
    USE <use-option> FOR FILTER <m>
      <resource-type> <resource-name> ...
      {Criterion Phrase} ... <conj> { Criterion Phrase} ...
    FROM FILTER <no.> SELECTIONS
      CHOOSE FROM
        <resource-name> ... <with-phrase> ...
      .
      PICK-AT-MOST <number> NOW <total-phrase>
    END <procedure-name>
  .
END RESOURCE-ALLOCATION

```

<procedure-name> is the name of one of the nineteen possible procedures listed in the above table. It is followed by the target paragraphs which are contained in each procedure. The syntax of the target paragraphs shall now be described:

TGT-TYPE <name-option>

This is the identifying sentence of the target paragraph and must occur only once per paragraph. The <name-option> is one of the following:

1. <target-name> <element-option>
2. **ANYONE** <element-option> <except-option>
3. **ALL-OTHERS** <element-option> <except-option>

1. <target-name> <element-option> this format may occur once or more and is used to identify targets by name. The <target-name> is from the list of players, sensor-transmitters or communication-transmitters in the UAN depending on the functional group of the procedure. All allowable options for this entry are summarised in the following table:

Functional Group	<target-name> is a:
Lethal Assignment	player
Lethal Engagement	player
NonLethal Engagement	communication or sensor transmitter

The <element-option> may occur zero or more times following each target name. It is used to further limit a target specification to particular component elements and has the following format:

WITH-ELEMENT: <element-name> ... **END**

where <element-name> occurs at least once and is from the list of elements in the UAN.

2. **ANYONE** may be used alone or with the stated qualifications. When appended with <element-option> it means that the filter criteria will be applied to all targets with elements matching the <element-option> specification. When appended with <except-option> it means the filter criteria will be applied to all targets except those named in <except-option>. The <element-option> has the following format:

WITH-ELEMENT: <element-name> ... **END**

where <element-name> occurs at least once and is from the list of elements in the UAN. The <except-option> has the following format:

EXCEPT <target-name>

where <target-name> is as described in the above table. The **ANYONE** option is required for EMCON/TURN-ON, EMCON/TURN-OFF, LAUNCH-START, GUNS-FREE and GUNS-TIGHT procedures.

3. **ALL-OTHERS** may be used alone or with the stated qualifications. When appended with <element-option> it means that the filter criteria will be applied to all targets not identified in other paragraphs but which do nonetheless have elements matching the <element-option> specification. When appended with <except-option> it means the paragraph will be applied to all targets not identified in other paragraphs and which are also not named in the exception list. The formats for <element-option> and <except-option> are as above.

Filtering Sentence

The filtering sentence (or filter for short) occurs at least once. It contains information about the resources and places criteria on the selection of those resources. It has three components:

1. **USE** <use-option> **FOR FILTER** <m>
2. <resource-type> <resource-name>
3. {Criterion Phrase}... <conj> {Criterion Phrase} ...

1. **USE** <use-option> **FOR FILTER** <m> Here <use-option> is one of the following: **INPUT** which must be used at least once in the first filter in a paragraph, or **FILTER** <n> **SELECTIONS** where <n> is a positive integer which is less than the integer <m> which labels the current filter. Each integer

The Type Data Base

Resource Allocation

<n> must have been used as the unique label of a previous filter. The following example helps to clarify the above explanation:

```
USE INPUT FOR FILTER 1
  WPN-TYPE weapon
  <filter 1 criteria>
USE FILTER 1 SELECTIONS FOR FILTER 2
  WPN-TYPE weapon
  <filter 2 criteria>
```

2. This statement occurs at least once per filter. The form of the entries depends on the functional group as summarised in the following table, with <resource-name> taken from the appropriate list in the UAN:

Functional Group	<resource-type>	<resource-name>
Lethal Assignment	SUB-TYPE	players
Lethal Engagement	WPN-TYPE	weapons
Non-Lethal Engagement	JAMMER-TYPE	disruptors
Movement	SUB-TYPE	players
Emission Control	SNR-TYPE	sensor receivers
Change Lethal Mode of Control	SUB-TYPE	players

3. This occurs once for each resource statement, and contains one or more {Criterion Phrase}'s. These phrases are the criteria that determine which resources are allocated to which targets. Each {Criterion Phrase} is either a threshold check or an equivalence check and the phrases are connected by a conjunction, <conj>, which can be either AND or OR. There are many different formats for specifying each {Criterion Phrase}. A complete list of these will be given later in appendix B3 describing resource allocation criteria. A filter including two examples of a {Criterion Phrase} is:

```
USE INPUT FOR FILTER 1
  WPN-TYPE missile-a_lchr
  IFF-STATUS IS-NOT FRIEND
  AND 3D-TGT-LOC WITHIN intercept_zone
  ...
```

Selection Sentence

This controls which resources are ultimately chosen. It can occur one or more times in a given target paragraph and it has the form:

```
FROM FILTER <n> SELECTIONS
  CHOOSE-FROM <resource-name> ... <with-phrase> ...
  PICK-AT-MOST <number> NOW <total-phrase>
```

Here <n> is a positive integer from the set of filter labels <m> used in the Filtering Sentences.

CHOOSE-FROM occurs only once in each selection sentence and provides a method for resource selection by type and quantity. It is followed by one or more <resource-name>...<with-phrase>... statements. Here <resource-name> is taken from the resources named in the Filtering Sentences and can be followed by <with-phrase> qualifiers. In some procedures certain <with-phrase> qualifiers are mandatory, as will be discussed later in appendix B3 discussing the 'with phrase' options.

Each **CHOOSE-FROM** statement is followed by only one **PICK-AT-MOST** statement which has four format options as shown below:

A:	PICK-AT-MOST <number> NOW
B:	PICK-AT-MOST <number> NOW <tot-number> TOTAL
C:	PICK-AT-MOST <number> NOW <filter-number> FILTER-TOTAL
D:	PICK-AT-MOST <number> NOW <tot-number> TOTAL <filter-number> FILTER-TOTAL

where <number>, <filter-number> and <tot-number> are positive integers. The format used can depend upon which procedure the statement occurs in:

Format A may be used in any procedure. It defines the maximum number of resources that the player can allocate (or de-allocate) when the current tactic is implemented.

Format B can only be used in procedures that involve the allocation of resources. (So it cannot be used to de-allocate resources.) (These procedures are listed in the following table.) It limits both the current number and total number of resources that can be employed when the particular tactic is implemented.

Format C and Format D may also only be used in procedures that allocate resources, and so also cannot be used to de-allocate resources. In this case the <filter-number> limits the total resources listed in the current **FILTER** that may be allocated in addition to any other limits that may be imposed.

The Type Data Base

Resource Allocation

The following table summarizes the meaning of <tot-number> and <filter-number> for each procedure in which they can be used:

Procedure Name	Meaning of <tot-number> and <filter-number>
LETHAL-ASSIGNMENT-QUEUE-ADD	Total subordinates in assignment queue for a target
LETHAL-ASSIGNMENT-START	Total subordinates assigned to a target
LETHAL-ENGAGE-QUEUE-ADD	Total weapons in engagement queue for a target
LETHAL-ENGAGE-START	Total weapons engaging a target
LETHAL-ENGAGE-FIRING-START	Total weapons firing at a target
JAMMER-QUEUE-ADD	Total jammers in jamming queue for a target
JAMMER-SPOT-ADD	Total jammers focusing spots at a target
LAUNCH-START	Total of all subordinates sent launch orders
EMCON/TURN-ON	Total sensors in an ON state
EMCON/TURN-OFF	Total sensors in an OFF or NON-OP state
GUNS-FREE	Total subordinates allowed in a guns-free state
GUNS-TIGHT	Total subordinates allowed in a guns-tight state

An example of a Selection Sentence is:

```
FROM FILTER 2 SELECTIONS
  CHOOSE FROM weapon WITH-TRACKER tracker_rx
  PICK-AT-MOST 1 NOW 2 TOTAL
```

Resource Allocation Criteria

There are many different formats in which a criterion phrase can be specified which vary according to the procedure being used. The general format is given by:

```
<variable> <relationship> <value> <units>
... RE: <qualifier> <descriptor> ...
```

where the entries will become apparent as each <variable> possibility is examined. The letters in the brackets after each variable name definition refer to the functional groups in which the variable can be used. The key is:

- LA - Lethal assignment
- LE - Lethal Engagement
- NL - Non-Lethal Engagement
- MT - Movement
- EC - Emission Control
- CC - Change Lethal Mode of Control
- ALL - all of the FUNCTIONAL GROUPS

ACTIVE-ATTACK-PRIORITY (LA,LE,NL)

This checks if the target element type is a member of the current **ATK-PRIORITIES** list. The priority is set in **MOVE-PLANS** in the TDB. The options are:

IS	YES
IS-NOT	NO

AVAILABLE-RESOURCE (ALL)

This counts the number of rounds that are presently held by the weapon. The options are:

AT-LEAST	<non-negative-integer>	(ROUNDS)
NO-MORE-THAN		

with qualifier:

RE:	<ordnance-name>	ORDNANCE
	ALL	

where: <ordnance-name> is from the list of ordnance or future players in the UAN. This entry takes on different meanings depending on which procedure it is used with. The meanings are summarized by the table:

Functional Group	Meaning
Lethal Engagement	AVAILABLE RESOURCE is the amount of the specified ordnance type remaining for the weapon named in <resource-type> in the Filtering Sentence following the keyword WPN-TYPE .
Lethal Assignment Movement Change Lethal Mode of Control	AVAILABLE RESOURCE is the amount of the specified ordnance type remaining for all weapons belonging to the subordinate named in <resource-type> in the Filtering Sentence following the keyword SUB-TYPE .
Emission Control NonLethal Engagement	AVAILABLE RESOURCE is the amount of the specified ordnance type remaining for all weapons belonging to the player evaluating the procedure.

BEEN-ASSIGNED (ALL)

Checks to see whether or not the target has been assigned to the player. The options are:

IS	YES
IS-NOT	NO

The Type Data Base

Resource Allocation

BELIEVED-ALIVE	(LA,LE,NL)
BELIEVED-DEAD	

Checks to see whether or not the player believes the target is alive or dead.

COMM-FREQ (NL)

This is the transmission frequency of the perceived emitter target. The options are:

>	<positive-real>	(HZ) (MHZ)
<		(KHZ) (GHZ)

CURRENT-ASGS (LA,MT,CC)

This is the total number of assignments currently made to the relevant subordinate, (LA), or subordinates, (MT,CC).. The options are:

AT-LEAST	<non-negative-integer>	(TGTS)
NO-MORE-THAN		

CURRENT-ENG'S (ALL)

The options are:

AT-LEAST	<non-negative-integer>	(TGTS)
NO-MORE-THAN		

This entry takes on different meanings depending on which procedure it is used with. The meanings are summarized by the table:

Functional Group	Meaning
Lethal Engagement	CURRENT-ENG'S is the total number of current engagements for the weapon system named in <resource-type> in the Filtering Sentence following the keyword WPN-TYPE.
Lethal Assignment Movement Change Lethal Mode of Control	CURRENT-ENG'S is the total number of current engagements for the subordinate named in <resource-type> in the Filtering Sentence following the keyword SUB-TYPE.
Emission Control NonLethal Engagement	CURRENT-ENG'S is the total number of current engagements for all weapon system belonging to the player evaluating the procedure.

CURRENT-SPOTS (NL)

This is the total number of spots presently being used by a jammer. The options are:

AT-LEAST	<non-negative-integer>	(TGTS)
NO-MORE-THAN		

CURRENTLY-JAMMED-FOR (LA,LE,MT,EC,CC)

Used to evaluate the length of time a resource has been jammed. The options are:

>	<non-negative-real>	(SEC)
<		(MIN)
		(HR)

This entry takes on different meanings depending on which procedure it is used with. The meanings are summarized by the table:

Functional Group	Meaning
Lethal Engagement	CURRENTLY-JAMMED-FOR is the longest time any tracker linked to the weapon resource has been jammed.
Lethal Assignment Movement Change Lethal Mode of Control	CURRENTLY-JAMMED-FOR is the longest time any sensor belonging to the subordinate player resource has been jammed.
Emission Control	CURRENTLY-JAMMED-FOR is the time the sensor resource has been jammed.
NonLethal Engagement	CURRENTLY-JAMMED-FOR has no meaning and is always assigned a value of -1.0 second

ELEV-ANGLE-TO-TGT (LA,LE,NL)

This is the angle between the range vector from resource to target and the pitch angle of the resource. For non-moving resources the pitch is zero. The options are:

>	<real>	(RADIANS)
<		(DEG)

EMCON-CONTROL-MODE (ALL)

Tests if a player as the authority carry out emission control of its sensors, as specified in the SDB using the **MODES-OF-CONTROL**: item **EMCON**. The options are:

IS	<player-name>
IS-NOT	SELF

where <player-name> is from the list of players in the UAN and **SELF** refers to the name of the player evaluating the procedure.

The Type Data Base

Resource Allocation

FIRED-BEFORE (LA,LE,NL)

Checks to see whether the player has previously fired at a target during its current perception of the target. (That is to say in the interval since it most recently became aware of the target.) When this criterion is used in the lethal assignment procedures, it checks if the current subordinate has previously fired at the target during the subordinate's current perception of the target. The options are:

IS	YES
IS-NOT	NO

FIRING-NOW (ALL)

Checks to see whether the weapon is currently firing at a target. If the weapon fires ordnance that is guided by the player, i.e. controlled ordnance, then **FIRING-NOW IS YES** is true from when the decision is made to shoot until the intercept point. If the ordnance is uncontrolled, which is either a simple projectile or a fully self guiding missile then **FIRING-NOW IS YES** is true from the decision to fire until the projectile is launched. The options are:

IS	YES
IS-NOT	NO

This entry takes on different meanings depending on which procedure it is used with. The meanings are summarized by the table:

Functional Group	Meaning
Lethal Engagement	FIRING-NOW IS YES when the weapon named in <resource-type> of the Filtering Sentence following the keyword WPN-TYPE is firing at the current perceived target.
Lethal Assignment Movement Change Lethal Mode of Control	FIRING-NOW IS YES when any weapon belonging to the subordinate named in <resource-type> of the Filtering Sentence following the keyword SUB-TYPE is firing at any target.
Emission Control NonLethal Engagement	FIRING-NOW IS YES when any weapon belonging to the player evaluating the procedure is firing at any target.

GAME-TIME (ALL)

This is the current simulated scenario time. The options are:

>	<positive-real>	(SEC)
<		(MIN)
		(HR)

HDG-CROSS-ANGLE (LA,LE,NL)

This is the target heading vector relative to the resource heading vector, both players must be moving. The options are:

>	<positive-real>	(RADIANS)
<		(DEG)

IFF-STATUS (LA,LE,NL)

Checks against the results on the IFF returned from intelligence sources. The options are:

IS	HOSTILE	NEUTRAL
IS-NOT	FRIEND	NOT-KNOWN

where: **HOSTILE** refers to an unfriendly target, **FRIEND** refers to a friendly target, **NEUTRAL** refers to a neutral target and **NOT-KNOWN** is used when the target's status cannot be determined.

INTERCEPTS-RESULTS-KNOWN (LA,LE,NL)

This will be true when none of the player's weapons are currently firing at a target.

JAM-CONTROL-MODE (ALL)

Tests if a player has the authority to non-lethally engage a target, as specified in the SDB using the **MODES-OF-CONTROL**: item **DISRUPT**. The options are:

IS	<player-name>
IS-NOT	SELF

where <player-name> is from the list of players in the UAN and **SELF** refers to the name of the player evaluating the procedure.

JAMMER-STATUS (NL)

Checks to see whether the jammer is on (**JMR-ON**), off (**JMR-OFF**), or non-operational (**JMR-NON/OP**). This status is set initially the SDB using the **SYSTEM**: data item. The options are:

IS	JMR-OFF
IS-NOT	JMR-ON
	JMR-NON/OP

The Type Data Base

Resource Allocation

LAST-COMM-PICKUP (NL)

This is the time since the last perception of the emitter target. The options are:

>	<positive-real>	(SEC)
<		(MIN)
		(HR)

LAST-SENSED (LA,LE,NL)

This is the time since the last sensory perception of the target. If a perception is derived or updated indirectly by messages from another player, the **LAST-SENSED** time is measured from the most recent physical detection of the target by the player initiating the message. The options are:

>	<positive-real>	(SEC)
<		(MIN)
		(HR)

LAUNCH-CONTROL-MODE (ALL)

Tests if a player is the authority to launch a subordinate, as specified in the SDB using the **MODES-OF-CONTROL**: item **LAUNCH**. The options are:

IS	<player-name>
IS-NOT	SELF

where <player-name> is from the list of players in the UAN and **SELF** refers to the name of the player evaluating the procedure.

LAUNCHES-SO-FAR (ALL)

This counts the number of resources that a player has already launched. The options are:

AT-LEAST	<non-negative-integer>	(VEHICLES)
NO-MORE-THAN		

with qualifier:

RE:	<resource-name>	RESOURCE
-----	-----------------	----------

where <resource-name> is from the list of players or future players in the UAN.

MOVING-TO-ENGAGE (LA,LE,NL)

Compares the current target with the target being pursued by the last reactive manoeuvre carried out using **MOVE-PLANS** tactics and evaluates as **YES** when the targets match. The options are:

IS	YES
IS-NOT	NO

NET-TYPE (NL)

Checks to see if the perceived communication transmitter is broadcasting on a net with the specified net type. The options are:

IS	<net-type>
IS-NOT	

where **<net-type>** is from the list of explicit-nets in the UAN.

OPERATIONAL-SUBS (ALL)

Can be used to test the number of operational subordinates. Players are operational as long as they are alive and have not fired all of their ammunition. The options are:

AT-LEAST	<non-negative-integer>	(PLAYERS)
NO-MORE-THAN		

with qualifiers:

RE:	<player-type>	PLAYER-TYPE
	ANY	
RE:	SELF	REFERENCE-CMDR
	SUB	

where **SELF** **REFERENCE-CMDR** would normally be used, except for Lethal Assignment, Movement and Change Lethal Mode of Control procedures where the form **SUB** **REFERENCE-CMDR** can be used to specify that the subordinates in question are in fact subordinates of the current subordinates.

OTHER-SYSTEMS-JAMMED-FOR (ALL)

This enables tactical decisions to be based on the status of named sensor receivers or communication systems other than the current resources. Since the resources must be named at least one **RE:** phrase is required each time this data item is used. The options are:

>	<non-negative-real>	(SEC)
<		(MIN)
		(HR)

with qualifiers:

RE:	<sensor-receiver>	SNR-TYPE
	ANY	
RE:	<comm-receiver>	COMMO-TYPE
	ANY	

PERCEPTION (ALL)

This tests the source of the perception of the target. A perception is considered to be **DIRECT-INTELL** when it has been derived from a sensor belonging to the player making the resource allocation decision and **INDIRECT-INTELL** when it is derived from an intelligence message from another player. Three **RE:** qualifiers may be used to make checks on perceptions. The first of these, **SNR-TYPE**, applies only when considering **DIRECT-INTELL** and the remaining two, **PLAYER-TYPE** and **COMMO-TYPE**, apply only for **INDIRECT-INTELL**. When both the **PLAYER-TYPE** and **COMMO-TYPE** qualifiers are used, both must be satisfied for the criterion to be met. When **COMMO-TYPE** is used with Lethal Assignment, Lethal Engagement and NonLethal Engagement it refers to the perception of the current **TGT-TYPE** being considered. When it is used with Movement, Emission Control and Change Lethal Mode of Control it considers all perceptions currently belonging to the player making the decision. The options are:

IS	DIRECT-INTELL
IS-NOT	INDIRECT-INTELL

with qualifiers:

RE:	<player-type>	PLAYER-TYPE
	ANY	
RE:	<sensor-receiver>	SNR-TYPE
	ANY	
RE:	<comm-receiver>	COMMO-TYPE
	ANY	

PERCEPTION-AGE (LA,LE,NL)

This is the time elapsed since the target was perceived by this player. The options are:

>	<positive-real>	(SEC)
<		(MIN)
		(HR)

REL-SUB-HDG (LA,LE,NL)

This is the projected ground angle between the velocity vector of the resource and the range vector of the target. If the resource is stationary this should not be used. The options are:

>	<positive-real>	(RADIANS)
<		(DEG)

REL-TGT-ALT (LA,LE,NL)

This is the altitude of the target relative to that of the resource. The options are:

>	<real>	(M) (MILES)
<		(KM) (ANGELS)
		(FT) (NM)

REL-TGT-HDG (LA,LE,NL)

This is the projected ground angle between the velocity vector of the target and the range vector from the target to the resource. If the target is stationary this should not be used. The options are:

>	<positive-real>	(RADIANS)
<		(DEG)

RELOAD STATUS (LE)

This checks if the weapon system is being reloaded. The options are:

IS	YES
IS-NOT	NO

RESOURCE-ALT (ALL)

This is the current altitude above mean sea level of the resource. The options are:

>	<real>	(M) (MILES)
<		(KM) (ANGELS)
		(FT) (NM)

RESOURCE-HDG (ALL)

This is the current heading of the resource measured anticlockwise from due east with values in the range $[-\pi \rightarrow \pi]$ or $[-180^\circ \rightarrow 180^\circ]$. The options are:

>	<real>	(RADIANS)
<		(DEG)

RESOURCE-SPD (ALL)

This is the current speed of the resource. It may be zero if the resource is not currently moving. The options are:

>	<real>	(M/SEC) (MPH)
<		(KM/HR) (FT/SEC)
		(NM/HR) (KTS)
		(KNOTS)

ROUNDS-FIRED-DURING-ENG (LE)

This checks the number of rounds fired by the weapon since the start of the engagement. The options are:

AT-LEAST	<non-negative-integer>	(ROUNDS)
NO-MORE-THAN		

with qualifier:

RE:	<ordnance-name>	ORDNANCE
		ALL

where <ordnance-name> is from the list of ordnance or future players in the UAN.

SALVOS-FIRED-DURING-ENG (LE)

This checks the number of salvos fired by the weapon since the start of the engagement.

AT-LEAST	<non-negative-integer>	(SALVOS)
NO-MORE-THAN		

with qualifier:

RE:	<ordnance-name>	ORDNANCE
		ALL

where <ordnance-name> is from the list of ordnance or future players in the UAN.

SENSOR-STATUS (LE,EC)

This is used with emission control to checks if the sensor is on, (**SNR-ON**), off, (**SNR-OFF**), or non-operational, (**SNR-NON/OP**). When used for Lethal Engagement it checks the status of the tracker sensor linked to the weapon being evaluated as a resource. The initial status is set in the SDB using the **SYSTEM:** item. The options are:

IS	SNR-OFF
IS-NOT	SNR-ON
	SNR-NON/OP

where the status values refer to a sensor receiver.

SKY-RADIANCE (ALL)

This is used to test the value of **SKY RADIANCE** set in the MOD input file. The options are:

IS	DAY
IS-NOT	NIGHT

where the values refer to whether the mission is taking place during the day or night.

SNR-FREQ (NL)

This is the transmission frequency of the perceived sensor transmitter. The options are:

>	<positive-real>	(HZ) (MHZ)
<		(KHZ) (GHZ)

SUB-ENG-CONTROL-MODE (LA,MT,CC)

Used to test the lethal engage control mode of each subordinate player, i.e. whether or not it has the authority to engage a target. This is specified in the SDB using the **MODES-OF-CONTROL:** item **ENGAGE**. The options are:

IS	<player-name>
IS-NOT	SELF
	SUB

where **SELF** means the player name of the player making the decision and **SUB** is the player name of the subordinate being considered as a candidate for receipt of an assignment or order.

SUB-STATUS (ALL)

Used to check if the subordinate is operational, (**SUB-OP**) or out of action, (**SUB-O/A**) in LA, MT and CC tactics. When used with LE, NL and EC tactics is actually tests the operational status of the current player. The options are:

IS	SUB-OP
IS-NOT	SUB-O/A

SUBORDINATE-JAMMED-FOR (ALL)

This can be used to allow a commander to make decisions to deal with situations where subordinates have jammed radars. The first two qualifiers, **PLAYER-TYPE** and **SNR-TYPE** are mandatory but these can take the keyword **ANY** to avoid referring to particular systems. The options are:

>	<non-negative-real>	(SEC)
<		(MIN)
		(HR)

with qualifiers:

RE:	<player-type>	PLAYER-TYPE
	ANY	
RE:	<sensor-receiver>	SNR-TYPE
	ANY	
RE:	SELF	REFERENCE-CMDR
	SUB	

where the **REFERENCE-CMDR** statement should only be used for Lethal Assignment, Movement and Change Lethal Mode of Control.

SYSTEM-STATUS (LE)

Checks if a tracking sensor is operational. The options are:

IS	OPERATIONAL
IS-NOT	

with qualifier:

RE:	<tracker-rx>	LINKED-TRACKER
-----	--------------	----------------

where <tracker-rx> is from the list of sensor-receivers in the UAN. The **LINKED TRACKER** statement is required and specifies the name of the trackers to be examined. This entry takes on different meanings depending on which procedure it is used with. The meanings are summarized by the table:

Functional Group	Meaning
Lethal Engagement	The status of all trackers of the specified type linked to the current weapon is examined. A status of OPERATIONAL is used if at least one tracker is operational.
Lethal Assignment Movement Change Lethal Mode of Control	The status of all trackers of the specified type linked to any weapon system belonging to the current subordinate player is examined. A status of OPERATIONAL is used if any weapon is linked to a operational tracker.
NonLethal Engagement Emission Control	The status of all trackers of the specified type linked to any weapon belonging to the decision making player is examined. A status of OPERATIONAL is used if any operational tracker is found.

TGT-ALT (LA,LE,NL)

This tests the altitude above mean sea level of the target. The options are:

>	<real>	(M) (MILES)
<		(KM) (ANGELS)
		(FT) (NM)

TGT-HDG (LA,LE,NL)

This tests the current heading of the target. Heading is measured anticlockwise from due east and lies in the range $[-\pi \rightarrow \pi]$ or $[-180^\circ \rightarrow 180^\circ]$. The options are:

>	<real>	(RADIANS)
<		(DEG)

TGT-SPD (LA,LE,NL)

This tests the current speed of the target. Speed may be zero if the target is not moving. The options are:

>	<real>	(M/SEC) (MPH)
<		(KM/HR) (FT/SEC)
		(NM/HR) (KTS)
		(KNOTS)

The Type Data Base

Resource Allocation

TIME-SEPARATION (LA,LE,NL)

This checks the expected time to go until the resource can intercept the target assuming both players maintain their current speed and heading. It can be infinite if no intercept is possible. The options are:

>	<positive-real>	(SEC)
<		(MIN)
		(HR)

TIME-SINCE-STATUS-CHANGE (ALL)

This tests the time elapsed since the last status change for a sensor system. A status change occurs when a sensor is turned on, turned off or becomes non-operational. The options are:

>	<positive-real>	(SEC)
<		(MIN)
		(HR)

with qualifier:

RE:	<sensor-receiver>	SNR-TYPE
------------	--------------------------------	-----------------

where the qualifier is optional for emission control but mandatory for all other types of tactics. In these procedures the sensor receiver *must be uniquely identified* by its type, so more than one sensor receiver of the given type exists it should not be used by these tactics.

TOTAL-APPROACHING-TARGETS (ALL)

Checks the number of targets of particular types on the player's perception list. The target must be approaching the resource to be added to the total. The options are:

AT-LEAST	<non-negative-integer>	(TGTS)
NO-MORE-THAN		

with qualifiers:

RE:	<player-name>	TGT-TYPE
	ANY	
RE:	<zone-name>	ZONE
	ANY	

where there must be at least one **TGT-TYPE** statement and zero or more **ZONE** statements. A <non-negative-integer> identifies how many targets must be present for the condition to be satisfied.

TOTAL-ASGS (LA,MT,CC)

This tests a value that is *one more* than the current number of assignments made to the relevant subordinate, (LA) or subordinates, (MT,CC). The options are:

AT-LEAST	<non-negative-integer>	(TGTS)
NO-MORE-THAN		

TOTAL-ENG'S (ALL)

This tests a value that is *one more* than the current number of engagements. The options are:

AT-LEAST	<non-negative-integer>	(TGTS)
NO-MORE-THAN		

This entry takes on different meanings depending on which procedure it is used with. The meanings are summarised by the table:

Functional Group	Meaning
Lethal Engagement	TOTAL-ENG'S is <i>one more</i> than the total number of current engagements for the weapon system named in <resource-type> in the Filtering Sentence following the keyword WPN-TYPE.
Lethal Assignment Movement Change Lethal Mode of Control	TOTAL-ENG'S is <i>one more</i> than the total number of current engagements for the subordinate named in <resource-type> in the Filtering Sentence following the keyword SUB-TYPE.
Emission Control NonLethal Engagement	TOTAL-ENG'S is <i>one more</i> than the total number of current engagements for all weapon system belonging to the player evaluating the procedure.

The Type Data Base

Resource Allocation

TOTAL-JAMMERS (ALL)

Checks the number of disruptor systems belonging to the player evaluating the procedure which match the jammer status and jammer type specified in the mandatory **RE:** statements. The options are:

AT-LEAST	<non-negative-integer>	(SYSTEMS)
NO-MORE-THAN		

with qualifiers:

RE:	ANY	JMR-STATUS
	ON	
	OFF	
	NON-OP	
RE:	<disruptor-name>	JMR-TYPE
	ANY	

where both **RE:** phrases are required exactly once and the **ANY** statement enables counting jammers regardless of their status or type.

TOTAL-SENSORS (ALL)

Checks the number of sensors belonging to the player evaluating the procedure which match the sensor status and sensor type specified in the mandatory **RE:** statements. The options are:

AT-LEAST	<non-negative-integer>	(SYSTEMS)
NO-MORE-THAN		

with qualifiers:

RE:	ANY	SNR-STATUS
	ON	
	OFF	
	NON-OP	
RE:	<sensor-receiver>	SNR-TYPE
	ANY	

where both **RE:** phrases are required exactly once and the **ANY** statement enables counting sensors regardless of their status or type.

TOTAL-SPOTS (NL)

The value of this entry is *one more* than the current number of spots used by a jammer. The options are:

AT-LEAST	<non-negative-integer>	(TGTS)
NO-MORE-THAN		

TOTAL-TARGETS (ALL)

Counts the number of targets of particular types on the player's perception list. The options are:

AT-LEAST	<non-negative-integer>	(TGTS)
NO-MORE-THAN		

with qualifiers:

RE:	<player-name>	TGT-TYPE
	ANY	
RE:	<zone-name>	ZONE
	ANY	

where there must be at least one **TGT-TYPE** statement and zero or more **ZONE** statements. A <non-negative-integer> identifies how many targets must be present for the condition to be satisfied.

TRACKING-STATUS (LE,EC)

This compares the status of a tracker with one of five possible status keywords. When used for Lethal Engagement procedures it looks at trackers linked to the current weapon resource, and determines its status with regard to the target currently being evaluated. When used for Emission Control it chooses the status closest to **FIRING** in the list (below) from all targets currently being sensed by the sensor resource. The options are:

IS	NOT-APPLICABLE
IS-NOT	ATTEMPTING-TRACK
	TRACKING
	COASTING
	FIRING

with qualifier:

RE:	<sensor-receiver>	SNR-TYPE
	ALL	

where the **RE:** statement should be omitted for Emission Control procedures and may be included for Lethal Engagement to specify a particular tracker.

The Type Data Base

Resource Allocation

When more than one tracking sensor receiver matches the constraints that with status closest to **FIRING** is selected.

VEHICLES-LEFT (LA,MT,CC)

Counts the number of vehicles of the type <resource-name> not yet launched. The options are:

AT-LEAST	<non-negative-integer>	(VEHICLES)
NO-MORE-THAN		

with qualifier:

RE:	<resource-name>	RESOURCE
-----	-----------------	----------

where <resource-name> is from the list of players or future-players occurs exactly once.

WPN-STATUS (ALL)

Checks to see whether the weapon is operational, (WPN-OP) or not (WPN-NON/OP). The options are:

IS	WPN-OP
IS-NOT	WPN-NON/OP

with qualifier:

RE:	<weapon-name>	RESOURCE
		ALL

The <weapon-name> is from the list of weapons in the UAN. This entry takes on different meanings depending on which procedure it is used with. The meanings are summarised by the table:

Functional Group	Meaning
Lethal Engagement	WPN-STATUS is the status of the weapon named in <resource-type> in the Filtering Sentence following the keyword WPN-TYPE . (NB: the RE: phrase, if specified, is ignored).
Lethal Assignment Movement Change Lethal Mode of Control	WPN-STATUS is the status of all weapons of a specified type belonging to the subordinate named in <resource-type> in the Filtering Sentence following the keyword SUB-TYPE . if at least one weapon of the specified type is operational, then WPN-STATUS is WPN-OP . (NB: if the RE: phrase is omitted, ALL is assumed).
NonLethal Engagement Emission Control	WPN-STATUS is the status of all weapons of a specified type belonging to the player evaluating the procedure. If at least one weapon of the specified type is operational, then WPN-STATUS is WPN-OP . (NB: if the RE: phrase is omitted, ALL is assumed).

2D-CLOSING-SPD (LA,LE,NL)

This is the relative ground speed along the range vector between the target and the resource. The options are:

>	<real>	(M/SEC) (MPH)
<		(KM/HR) (FT/SEC)

2D-DIST (LA,LE,NL)

This is the two-dimensional ground distance between the target and the resource. The options are:

>	<positive-real>	(M) (MILES)
<		(KM) (NM) (FT)

2D-REL-TGT-OFFSET (LA,LE,NL)

This tests the two-dimensional ground distance of the resource from the target's projected point of closest approach to the resource. When the resource is approaching this point the range will be positive, when receding the range will be negative. The options are:

>	<positive-real>	(M) (MILES)
<		(KM) (NM) (FT)

The Type Data Base

Resource Allocation

2D-REL-TGT-UP/DOWN-RNG (LA,LE,NL)

This tests the two-dimensional ground distance of the target from its projected point of closest approach to the resource. When the target is approaching this point the range will be positive, when receding the range will be negative. The options are:

>	<positive-real>	(M) (MILES)
<		(KM) (NM) (FT)

3D-DIST (LA,LE,NL)

This tests the three-dimensional distance between the resource and the target. The options are:

>	<positive-real>	(M) (MILES)
<		(KM) (NM) (FT)

3D-TGT-LOC (LA,LE,NL)

This checks to see whether a target is inside a zone or not. The options are:

WITHIN	<zone-name>
OUTSIDE	

with qualifier:

RE:	YOUR-LOC	REFERENCE-LOC
	SUB-LOC	

where <zone-name> is from the list of zones in UAN. The **REFERENCE-LOC** qualifier appears once or not at all, where **YOUR-LOC** refers to the location of the player that has the resource and **SUB-LOC** refers to the location of the resource.

Resource Allocation 'With' Options

The action of each procedure can be modified by using the 'with' options outlined below.

WITH-TRACKER <tracker-name>

Used with **LETHAL-ENGAGE-START** only. This entry is used when starting an engagement, it identifies a tracking sensor receiver that starts the engagement and it can occur zero or more times. The <tracker-name> can be the name of a tracking sensor receiver or the keyword **ANYONE**. There are three requirements before a tracker will be used to initiate an engagement:

1. it must not be in a non-operational state
2. the **MAX-PARALLEL-TRACKS** for that tracker must not be exceeded

3. the tracker must be listed in the **SNR-ELE-INTERACTIONS** list of the target.

WITH-TRACKER-GROUP <tracker-name> <sustain-phrase>
[TURN-ON <real> <time-uom> AFTER-FIRING]

.

END-TRACKER-GROUP

This is used where,

<tracker-name> is from the sensor-receivers listed in the UAN and must be followed by one <sustain-phrase> which is either

REQ-TO-SUSTAIN-ENG (for trackers required to sustain an engagement) or

OPT-TO-SUSTAIN-ENG (for trackers not required to sustain an engagement).

The units represented by <time-uom> are either **(SEC)**, **(MIN)** or **(HR)**.

This entry is used with **LETHAL-ENGAGE-START** only. It is used to define a set of tracking sensors for use during engagements. All trackers are required to start the engagement and at least one tracker is required to sustain an engagement, i.e. have **REQ-TO-SUSTAIN-ENG** set.

The **TURN-ON** phrase may be used once to specify that the preceding tracker is not to be turned on until a specified time after firing, if this is omitted the tracker is turned on when the engagement starts, which precedes firing. All the trackers must also satisfy the requirements stated above for the **WITH-TRACKER** item. N.B. do not use **WITH-TRACKER** and **WITH-TRACKER-GROUP** together, if neither of these is listed then the engagement starts without a tracker.

WITH-ORDNANCE <ordnance-name>

Used with **LETHAL-ENGAGE-FIRING-START** only. It is used for the commencement of firing during an engagement and it must occur at least once. It identifies the ordnance used by the weapon. The <ordnance-name> can be the name of ordnance listed in the UAN or a future player resource from the list in the UAN or the keyword **ANYONE**.

WITH-ELEMENT <element-name>

Used with **LETHAL-ENGAGE-FIRING-START** only. This entry is used for the commencement of firing during an engagement. It identifies the target element to be attacked by the weapon and must occur at least once. The <element-name> can be either the name of one of the elements belonging to the target being attacked or the keyword **ANYONE**. NB: All **LETHAL-ENGAGE-FIRING-START** procedures must have a minimum of one **WITH-ORDNANCE** and one **WITH-ELEMENT**.

The Type Data Base

Resource Allocation

WITH-VEHICLE <vehicle-name>

This is used for launching subordinates into motion. It must occur once in a **LAUNCH-START** procedure. The <vehicle-name> can either be a player type name or the name of the future player resource.

WITH-PLAN <plan-name>

This is used for launching subordinates into motion. It must occur once in a **LAUNCH-START** procedure. It identifies the name of a movement plan that will be invoked upon launch. The initial heading for a launched player is the heading of the parent player. This data item may be used in a **LETHAL-ENGAGE-FIRING-START** procedure when **WITH-ORDNANCE** refers to a future player.

WITH-SALVO-SIZE <positive-integer>

This can be used once only in a **LETHAL-ENGAGE-FIRING-START** procedure. It specifies the number of rounds that can be fired in each salvo to be fired by the chosen weapon. When this is present the **SALVO-FIRING** entry in the TDB will be overridden.

WITH-TGT-CUING-FOR-LOC <loc-id>

The use of this is optional and it can be used in Lethal Assignment procedures and Lethal Engagement procedures. It is used to cause dynamic changes in the heading of one or more locations. A **WITH-TGT-CUING-FOR-LOC** causes identified locations to be cued towards, i.e. its heading orientated towards, the current target. If this item is used in a Lethal Assignment procedure, a **SUB-CUING** message is sent to the subordinate player and the subordinate will cue its identified locations toward the target upon receipt of the message. N.B. Do not use cuing with moving players since their heading is always in the direction of motion.

WITH-SDB-CUING-FOR-LOC <loc-id>

The use of this is optional and it can be used in Lethal Assignment procedures, Lethal Engagement procedures, Emission Control procedures and Change Lethal Mode of Control Procedures. It is used to dynamic reset the heading of player locations. It causes the identified locations to be cued to their original heading as specified in the SDB **HDG:** phrase or the default of due east. If this item is used in a Lethal Assignment procedure or a Change Lethal Mode of Control procedure, a **SUB-CUING** message is sent to the subordinate. N.B. Do not use cuing with moving players since their heading is always in the direction of motion.

1.3. The Susceptibility Block

Susceptibility is optional but must be present for an element to be detected by sensors, since it defines how easy it is for each sensor type to detect the element. When absent the element is effectively invisible. This data item is split into four categories and each category can only appear once within a susceptibility.

All Sensor Types

SNR-ELE-INTERACTION

Infrared:

IR-INTENSITY IR-RAD-TABLE

TGT-REFLECTIVITY OPT-CS

Optical:

INHERENT-CONTRAST OPT-CS

Radar:

RCS-TABLE

All Sensor-Element-Types

SNR-ELE-INTERACTION

Name Format

Defines the sensors which can detect the element whose susceptibility block is being defined. If this data item is omitted the element is assumed to be invisible, since no sensors can detect it. The only entries are the sensor names, from the list sensor-receivers in the UAN. The names may include radar, optical, infrared and RF (radio frequency) sensor types. Each element must have a corresponding signature for each type of sensor, for example, if the list includes an infrared sensor receiver then there must be an appropriate IR-RAD-TABLE data item.

Infrared Sensors

IR-INTENSITY

Dimensional Format

IR-RAD-TABLE

This is required for any element that might be detected by an infrared sensor during an engagement and it describes the infrared signature of that element. IR-INTENSITY and IR-RAD-TABLE are synonyms for the same command and can be used interchangeably. The input is in a dimensional format, with some variation in the number of DIMENSIONS statements and their ordering being permitted. The format for the input is:

The Type Data Base

Element Susceptibilities

```

IR-RAD-TABLE
  DIMENSION 1  <dim-spec>
    <dim-val>  <dim-val>
  DIMENSION 2  <dim-spec>
    <dim-val>
  DIMENSION 3  <dim-spec>
    <dim-val>
  IR-RAD (WATTS/STERADIAN)
    <ir-energy-density> ...
.
.
.
END IR-RAD-TABLE

```

The possible labels of each **DIMENSION** statement include **IR-BAND**, which names the infrared frequency bands, within which the element has a cross-section. These band's names must be declared in the UAN. This label is optional, but when present must always be attached to the first **DIMENSION** statement. The remaining two labels of **AZ** (for azimuthal range) and **EL** (for elevation range) must be present but may be given in any order. If the range of specified azimuths are always positive the signature is implicitly symmetric, asymmetric ranges can be specified by entering negative azimuthal ranges explicitly. The maximum angular ranges are thus $[-180^\circ \rightarrow 180^\circ]$ or $[-\pi \rightarrow \pi]$ for azimuthal ranges specified in units of (DEG) or (RADIANS) respectively. Elevation ranges are always assumed to be asymmetric and thus have ranges of $[-90^\circ \rightarrow 90^\circ]$ or $[-\pi/2 \rightarrow \pi/2]$ when specified in units of (DEG) or (RADIANS) respectively. Note that both zero azimuth and elevation is aligned with the target's heading.

The infrared cross-section for each specified combination of **IR-BAND**, **AZ** and **EL** range is given in fixed units of W sterad^{-1} after the keyword **IR-RAD WATTS/STERADIAN**.

TGT-REFLECTIVITYDimensional Format

This is required for any element that can be detected by an infrared sensor, and it defines the reflectivity values for that element. The command is a table with one list specified by a single **DIMENSION** statement

IR-BAND followed by the name of an infrared band selected from those declared in the UAN or the keyword **DEFAULT**.

REFLECTANCE this has the entry (**NO-UNITS**) which is followed by a real number which occurs once for each infrared band name and defines the target's reflectivity in that infrared band.

OPT-CSDimensional Format

This is required for any element that can be sensed by either optical or infrared sensors. It simply defines the projected area of the target as seen from various

directions. The command is in tabular format with two lists of angular ranges, namely azimuth **AZ** and elevation **EL**, associated with each **DIMENSION** statement. These can be specified in either order using either **(DEG)** or **(RADIANS)** as units. As with the **IR-INTENSITY** entry a target's symmetry in azimuth may be implied by only specifying positive azimuthal ranges, with asymmetrical objects being defined explicitly using the full range of azimuths from -180° to 180° or $-\pi$ rad to π rad. The range of elevation angles is always from -90° to 90° or $-\pi/2$ rad to $\pi/2$ rad since symmetry is never assumed in the vertical plane. Again the zero elevation and altitude vector is defined with respect to the target's heading.

The optical cross-section itself is defined with the entry **OCS** specified as a real number with fixed units of **(M2)**, (i.e. square metres). There is one entry per elevation interval. As an example a spherical target with a projected area of 10 m^2 would have the following **OPT-CS** table:

OPT-CS DIMENSION 1 AZ (DEG) 0.0 180.0 DIMENSION 2 EL (DEG) -90.0 90.0 OCS (M2) 10.0 END OPT-CS
--

Optical Sensors

INHERENT-CONTRAST

One-line Format

This is required for any element that can be sensed with optical sensors and it defines the contrast of an element with its background. For each sensing chance for an optical sensor this data item is used to compute the target's contrast as perceived by the sensor. The entry is a real number with **(NO-UNITS)**.

OPT-CS

Dimensional Format

This entry is required for both optical and infrared cross-sections and was defined above for infrared cross-sections.

Radar Sensors

RCS-TABLE

Dimensional Format

Required for an element that can be detected by radar and it defines the radar cross section of the element. The input may have two, three or four dimensions and takes a similar form to that of **IR-RAD-TABLE**. The allowed labels of each **DIMENSION** statement and their ten possible combinations are listed in the columns of the following table:

The Type Data Base

Element Susceptibilities

DIMENSION 1	AZ	EL	FREQ	FREQ	POL	POL	FREQ	FREQ	POL	POL
DIMENSION 2	EL	AZ	AZ	EL	AZ	EL	POL	POL	FREQ	FREQ
DIMENSION 3			EL	AZ	EL	AZ	AZ	EL	AZ	EL
DIMENSION 4							EL	AZ	EL	AZ

The labels of each **DIMENSION** statement are summarized in the following table:

Label	Description
AZ	The azimuthal ranges given as real number in the range $[0 \rightarrow 180]$ (DEG) or $[0 \rightarrow \pi]$ (RADIANS) for symmetrical signatures, or $[-180 \rightarrow 180]$ (DEG) or $[-\pi \rightarrow \pi]$ (RADIANS) for asymmetrical signatures
EL	The elevation range given as real numbers in the range $[-90 \rightarrow 90]$ (DEG) or $[-\pi/2 \rightarrow \pi/2]$ (RADIANS)
FREQ	The frequency of the radiation in units of (HZ), (KHZ), (MHZ) or (GHZ)
POL	The polarization of the radiation which is one of HORIZ-POL , VERT-POL , LEFT-CIR-POL , RIGHT-CIR-POL or DEFAULT

Specifying polarized radiation as being of type **DEFAULT** is equivalent to omitting the polarization entry completely, i.e. the radiation is effectively unpolarized. Furthermore, if the **FREQ** label is omitted the cross section is independent of the frequency of the radiation, i.e. the surface is a 'grey' reflector. After the final **DIMENSION** statement the radar cross-section is given with the **RCS** keyword using fixed units of (**M2**) as follows:

RCS (M2) <rcs>

where <rcs> is a real number and occurs once for each interval in the preceding dimension. Note that the radar cross section is an effective area, which is not the same as the true geometrical area. (The effective area is the area of a perfect reflector of radio waves of the appropriate polarization and frequency.)

1.4. The Capability Block

Each system must have a capability block which describes the physical capabilities of that system. This section is divided according to the system whose capabilities are being described, and these occur in the following sequence: Mover, Weapon, Thinker, Communication Receiver, Communication Transmitter, Disruptor, Sensor Receiver, Sensor Transmitter.

1.4.1. Mover

Required:

MAX-ACCELERATION	MIN-TURN-RADIUS
MOVER-ALTITUDE-LIMITS	MOVER-CLIMB/DIVE-LIMITS
MOVER-SPEED-LIMITS	

Optional:

COMMIT-ALT	FUEL-USAGE
MAX-ACCELERATION	NAV-ERROR-DATA
TERRAIN-FOLLOW-SMOOTHING-FACTOR	

Required Entries

MAX-ACCELERATION

One-line Format

Describes the maximum rate of change of speed. The inputs are the acceleration given as a non-negative real number with units of either (M/SEC/SEC) or (FT/SEC/SEC). If this is set to zero the mover's speed cannot change.

MIN-TURN-RADIUS

One-line Format

Limits the turn-radius of a mover, with the arc of the turn being three dimensional. The turn radius is entered as a positive real number with units of (M), (KM), (FT) or (MILES). The smaller the turn-radius the higher the acceleration of the turn.

MOVER-ALTITUDE-LIMITS

Block Format

Required for a mover system that can reactively manoeuvre. Defines the minimum and maximum altitude of a mover with the entries: MIN-ALT and MAX-ALT. Both entries are followed by an altitude specified as a real number with units of (M), (KM), (FT), (MILES) or (ANGELS). The altitudes can have any value but are always specified with respect to mean sea level.

MOVER-CLIMB/DIVE-LIMITS

Block Format

Required for a mover system that can reactively manoeuvre to do terrain following/terrain avoidance/threat avoidance. Defines the rate of change of altitude of a mover with the two entries: MAX-DIVE-RATE and MAX-CLIMB-RATE. Both of these entries are followed by a positive real number specifying the climb or dive rate with units of (M/SEC), (KM/HR), (FT/SEC) or (MPH). The default values are both zero,

The Type Data Base

Mover Capabilities

which implies that the mover will not be able to change altitude in its reactive manoeuvres.

MOVER-SPEED-LIMITSBlock Format

Describes the minimum and maximum speed limits of a mover by the entries: **MIN-SPD** and **MAX-SPD**. These entries are followed by positive real numbers which define the speeds with units of (**M/SEC**), (**KM/HR**), (**FT/SEC**) or (**MPH**).

Optional Entries**COMMIT-ALT**Dimensional Format

Defines a table of altitudes which vary according to the mover's dive slope. If this item is present and the mover has **MOVE-PLANS** tactics that include the **REL-TGT-ALT** criterion then this criterion will be replaced with an altitude from the **COMMIT-ALT** table determined by the mover's dive angle at that time. If **COMMIT-ALT** is omitted, the threshold value in the **MOVE-PLANS** will not be changed. The format contains one list whose **DIMENSION** statement is labelled by the keyword **DIVE-SLOPE** and has inputs:

DIVE-SLOPE entries are real numbers with units of either (**DEG**) or (**RADIANS**)

DECIDE-ALT entries are real numbers, one per slope interval, with units of (**M**), (**KM**), (**FT**), (**MILES**), (**NM**) or (**ANGELS**)

FUEL-USAGEDimensional Format

This data item is optional and specifies how much fuel is used as a function of altitude and speed. A moving player is allowed to participate in the scenario only as long as it has sufficient fuel. The table is specified with two lists whose **DIMENSION** statements are labelled with the keywords **ALT** and **SPEED** and which use the following inputs:

ALT is the altitude above mean sea level with units of (**M**), (**KM**), (**FT**), (**MILES**) or (**ANGELS**)

SPEED is the speed of the mover with units chosen from (**M/SEC**), (**KM/HR**), (**FT/SEC**) or (**MPH**).

BURN-RATE specifies the rate of consumption of fuel in units of (**KG/SEC**), (**KG/HR**) or (**LBS/HR**) for each appropriate speed and altitude range.

If **FUEL-USAGE** is used the appropriate **FUEL** entry in the **PLAYER-STRUCTURE** must also be set for the mover's fuel consumption to be correctly modelled.

NAV-ERROR-DATABlock Format

Defines the magnitude of navigation errors of a mover system. When this is used the **MAG-DIP-ANGLE** entry in the SDB is required and flight path points will deviate from the desired points to represent errors in navigation. The inputs are:

Label	Description
MIN-BASE-HDG MAX-BASE-HDG	These entries define the range of uniformly distributed errors in heading in units of (DEG) or (RADIANS).
VERT-AX-MEAN VERT-AX-DEV	The mean and standard deviation of normally distributed errors in the vertical plane in units of (DEG) or (RADIANS).
YAW-ALIGN-MEAN YAW-ALIGN-DEV	The mean and standard deviation of errors around the yaw axis in units of (DEG) or (RADIANS).
MIN-SPEED-ERROR MAX-SPEED-ERROR	The speed is multiplied by a real number with (NO-UNITS) that is randomly selected value lying between these two values.

TERRAIN-FOLLOW-SMOOTHING-FACTOR

One-line Format

This data item defines the minimum distance between the points defining a mover's path whilst it is following terrain. These points will be selected so that they are always at least the distance specified by TERRAIN-FOLLOW-SMOOTHING-FACTOR apart. The two inputs are a positive real number with its units of (M), (KM), (FT), (MILES) or (NM). The default smoothing factor is three times the MIN-TURN-RADIUS. N.B. care should be taken when paths are chosen with this smoothing factor close to the value of the MIN-TURN-RADIUS.

The Type Data Base

Weapon Capabilities

1.4.2. Weapon

Required:

RESOURCE-DISAGGREGATION
WPN-SPD-CAPABILITY

WPN-PK

Optional:

NUM-SIMULTANEOUS-ROUND
RELOAD-CHARACTERISTICS
WPN-PK-DEGRADE
WPN-TIME-DELAYS

PLATFORM-VEL-ATTEN
WPN-CHARACTERISTICS
WPN-TIME-DELAY-TABLE

Required Entries**RESOURCE-DISAGGREGATION**Dimensional Format

This is a required data item for a weapon that has resources which can become future players. It associates the names of the future player resources with the names of the resulting player types once the resource has been 'disaggregated'. The command has just one list whose **DIMENSION** statement is labelled with the keyword **RESOURCE-TYPE**. The entries have the following syntax:

RESOURCE-TYPE is the name of the resource which is selected from the list of future players in the UAN

CREATED-PLAYER which is the name of the created player's type selected from the list of players in the UAN. One such identification should occur for each resource name.

WPN-PKDimensional Format

Defines the probability of kill of a given weapon against a given target. The table must include the **DIMENSION** statement labelled with the keyword **ELEMENT-TYPES**, this being always the first list in the table and is used to identify the target elements. These elements must be drawn from those whose names were declared in the UAN although the final entry to the list must be the **DEFAULT** keyword. This is used to describe the effectiveness of the weapon against any target not explicitly named.

Seventeen other lists can be included, in any order, each of which being used to describe the capability of the weapon in differing circumstances. These are described in the table below:

Label	Description	Form of Entry	Allowed Units
ABS-OFFSET	Absolute horizontal offset of target from weapon's boresight.	Non-negative real number	(M) (KM) (FT) (MILES) (NM)
ALT	The target's altitude relative to the weapon	Real number.	(M) (KM) (FT) (NM) (MILES) (ANGELS)
COLLATERAL-ELEMENTS	P(k) values for damage to elements other than targets	The names of the elements drawn from the UAN.	
ELAPSED-COAST-TIME	Elapsed time since the weapon's trackers lost lock and started to coast	Non-negative real number	(SEC) (MIN) (HR)
HDG-CROSS-ANGLE	Angle formed by the target and weapon velocity vectors	Non-negative real number	(RADIANS) (DEG)
JMR-TYPES	Disruptors that might affect a kill probability	Names of implicit disruptors from the UAN.	
OFFSET	Horizontal offset of the target from the weapon's boresight	Real number	(M) (KM) (FT) (MILES) (NM)
ORDNANCE-TYPES	The effectiveness of the weapon when used with this ordnance.	Names of ordnance from the UAN	
REL-ST-DIVE-ALT	Altitude of attacker at the start of a dive relative to the target	Real number	(RADIANS) (DEG)
REL-TGT-EL-ANG	Relative elevation angle from the weapon to the target	Real number	(RADIANS) (DEG)
REL-TGT-HDG	Target heading relative to the weapon	Non-negative real number	(RADIANS) (DEG)
RNG	Target ground range or up/down range ³	Non-negative real number or real number	(M) (KM) (FT) (MILES) (NM)
TGT-ALT-AGL	Target altitude above ground level	Non-negative real number	(M) (KM) (FT) (NM) (MILES) (ANGELS)
TGT-SPD	Target speed relative to weapon, negative speeds imply target is receding, positive that it is approaching.	Real number	(M/SEC) (MPH) (KM/HR) (FT/SEC)
TRACKER-TYPES	Identifies linked tracking sensor receivers	Names of tracking sensors from the UAN	
VERTICAL-SPD	Vertical speed of target, positive speeds indicate the target is climbing, negative that it is diving	Real number	(M/SEC) (KM/HR), (FT/SEC) (MPH)
WPN-VEL-EL-ANG	The elevation angle of the ordnance at time of firing	Real number	(RADIANS) (DEG)

³ The target range has a different meaning depending on whether or not it used in conjunction with either of the **OFFSET** entries or not. When neither **OFFSET** nor **ABS-OFFSET** is present it means the projected ground range of the target from the weapon, and so is always positive. When either **OFFSET** or **ABS-OFFSET** is present the range is that of the target from the point of closest approach of the target to the weapon. When the target is approaching this point, and so approaching the weapon, the range will be positive, when receding the range will be negative.

The Type Data Base

Weapon Capabilities

The format of the input is:

```
WPN-PK
  DIMENSION 1  ELEMENT-TYPES
    <element-types>
    <Optional DIMENSION 2-18 Label>
END WPN-PK
```

The optional labels may be used in any order but once an initial ordering and selection is made this selection must be retained through all the remaining entries. In other words if the weapon type's effectiveness against a certain element required, for example, the **TGT-SPD** identifier then all the other elements must also include this identifier in their P_K entries too. The optional **WPN-PK-DEGRADE** command is useful in this case, as it can be used to degrade a selected P_K without unnecessarily complicating all other entries.

WPN-SPD-CAPABILITYDimensional Format

This is a required data item for a weapon unless it only fires ordnance modelled using **FUTURE-PLAYERS**. It defines the speed of the ordnance as a function of time as it moves towards the target. This data item is used in conjunction with the **WPN-CHARACTERISTICS** item to define a step function of weapon speed versus flyout time. If a table defining weapon speed dependent only on time is required, then the first **DIMENSION** statement is labelled with the keyword **TIME** and the table consists a set of time intervals with each interval associated with an average ordnance speed, **AVG-SPD**. Alternatively, if the ordnance speed depends also on the target altitude then an optional **DIMENSION** statement labelled with either of the keywords **REL-TGT-ALT** or **TGT-ALT-AGL** can precede the list of time intervals. The possible formats are thus:

```
WPN-SPD-CAPABILITY
  DIMENSION 1  TIME  <time units>
    <time>  <time> ...
  AVG-SPD  <s-units>
    <speed> ...
END WPN-SPD-CAPABILITY
```

OR:

```
WPN-SPD-CAPABILITY
  DIMENSION 1  [REL-TGT-ALT | TGT-ALT-AGL] <altitude units>
    <altitude>  <altitude> ...
  DIMENSION 2  TIME  <time units>
    <time>  <time> ...
  AVG-SPD  <speed units>
    <speed> ...
END WPN-SPD-CAPABILITY
```

The altitude keywords **REL-ALT-TGT** refers to the relative altitude of the target to the weapon and **TGT-ALT-AGL** refers to the altitude of the target above ground level. The altitude units may be (M), (KM), (FT), (MILES) or (NM). The time units may be one of (SEC), (MIN) or (HR), whilst the speed units may be selected from (M/SEC), (KM/HR), (FT/SEC) or (MPH)

Optional Entries

NUM-SIMULTANEOUS-ROUND

One-line Format

Defines how many targets can be engaged at once by a given weapon system. The two entries are a positive integer number giving this limit followed by the keyword (**NO-UNITS**).

PLATFORM-VEL-ATTEN

One-line Format

This data item is optional, but recommended. It defines whether or not the initial velocity of the element owning the weapon is added to the speed of the weapon's ordnance. This entry is only meaningful for moving elements although it does no harm when included for other elements. The entries are: a real number serving as a flag, followed by the keyword (**NO-UNITS**). When the flag's value is zero, the initial velocity is not considered, when the flag is set to be unity or it is included. The default value is zero. If the initial velocity is considered in the flyout calculation the model calculates the component of the mover's velocity along the range vector from the weapon to the target and then adds this to the ordnance's flyout velocity.

RELOAD-CHARACTERISTICS

Dimensional Format

Defines the conditions and time delays for reloading a weapon system. If this data item is used a weapon system will be given a reloading status when its ammunition drops below a threshold value. The format for the input is tabular with a single **DIMENSION** statement with the label **AMMO-TYPES** which list the various kinds of ordnance or future players which may be used with the weapon. For each type of ordnance a description of the reloading characteristics of the weapon for this sort of ammunition is given. The format is:

```
RELOAD-CHARACTERISTICS
  DIMENSION 1 AMMO-TYPE
    <ammo-type> ...

  EXTRAS (ROUNDS) TIME <t-units> THRESHOLD (ROUNDS) RELOAD (ROUNDS)
  <extra-round>   <time-delay>   <threshold>         <reload-amt>

END RELOAD-CHARACTERISTICS
```

The description of the reloading characteristics of the weapon is headed by a line with the following components:

The Type Data Base

Weapon Capabilities

Entry	Form of Input	Definition
EXTRAS	Positive integer <extra-round>	Total stock of ammunition available for reloading
TIME	Positive real number <time-delay>	Time required to reload in units of (SEC), (MIN) or (HR).
THRESHOLD	Integer <threshold>	When the amount of ammunition available is no longer above this threshold begin reloading
RELOAD	Positive integer <reload-amt>	Number of rounds to reload

WPN-CHARACTERISTICSOption Format

This entry defines characteristics of weapons using the entries defined in the table below. None of the entries are compulsory and if omitted each characteristic has a default, indicated by shading. If the entire command is omitted then all values assume their defaults. In two cases the default option is actually the only option available.

Option	Definition
IMPLICIT-FLYOUT	Redundant option
3D-FLYOUT	Redundant option
INTERCEPTOR-ENVELOPE-P(K)	Compute weapon P_K when weapon hits the target.
LAUNCH-ENVELOPE-P(K)	Compute weapon P_K when weapon is launched.
CONTROLLED	Weapon ordnance guided by the shooter after launch
UNCONTROLLED	Shooter has no control over ordnance after launch.
SELF-DESTRUCTION	The weapon and its location will be destroyed at intercept
NO-SELF-DESTRUCTION	The weapon and its location will not be destroyed at intercept
ABORT-SALVO-WHEN-COASTING	Current salvo is terminated whenever a linked tracker starts to coast
CONTINUE-SALVO-WHEN-COASTING	Current salvo will continue when a until a linked tracker has coasted for more than its MAX-COAST-TIME

WPN-PK-DEGRADEDimensional Format

Defines degrade factors for kill probabilities of a given weapon against a given target. This is an optional data item, if it is omitted the kill probabilities are used from **WPN-PK** without changes. The format for the input is identical to that of **WPN-PK** but with the **DEGRADE-FACTOR** statement replacing **PK**. It has the form:

DEGRADE-FACTOR	(NO-UNITS)	<degrade>
----------------	------------	-----------

Here <degrade> is a real number to be multiplied by a **WPN-PK** value to determine the effective P_K . This command is useful in that it allows some target elements to have different dependencies on the optional factors controlling the weapon's P_K values without all elements in the initial **WPN-PK** having to include these items too.

WPN-TIME-DELAY-TABLEDimensional Format

This is an optional way of defining firing time delays, it can be used when it is desirable to represent the effects of defensive ECM in delaying the weapon firing process. Each weapon firing causes a search of the disruptor systems on the target. If an operating disruptor, i.e. one whose status is **ON**, is found which is listed in the first **DIMENSION** statement labelled with the keyword **JAMMER-TYPE** the **SHOOT-TIME-DELAY** corresponding to the relative target altitude interval found in the second **DIMENSION** statement, **REL-TGT-ALT**, will be used to determine the delay. The input has the following format:

<pre> WPN-TIME-DELAY-TABLE DIMENSION 1 JAMMER-TYPE DEFAULT <jam> ... DIMENSION 2 REL-TGT-ALT <alt-units> <alt> <alt> ... SHOOT-TIME-DELAY <time-units> <delay> END WPN-TIME-DELAY-TABLE </pre>

where,

<jam> is from the list of jammers in the UAN (NB: the entry **DEFAULT** is compulsory).

DIMENSION 2 occurs once more than the number of <jam> entries.

<alt-units> is (M), (KM), (MILES), (NM) or (FT).

<alt> is a real number and occurs two or more times. It defines the relative target altitude values in increasing order.

<time-units> are one of (SEC), (MIN) or (HR).

<delay> is a non-negative real number that defines fire delay values. One <delay> is required per altitude interval.

The Type Data Base**Weapon Capabilities****WPN-TIME-DELAYS**Block Format

This data item is optional, but recommended. It defines the physical time delays inherent in firing a weapon with the help of the two entries:

SHOOT-TIME-DELAY which describes the time between deciding to fire and firing,

SALVO-FIRING-DELAY which describes the time delay between firing rounds.

The time delays themselves are entered as positive real numbers with units chosen from **(SEC)**, **(MIN)** or **(HR)**.

1.4.3. Thinker

Required:

RESOURCE-DISAGGREGATION
TIME-TO-THINK

TIME-BEFORE-DROP

Optional:

MAX-CONCURRENT-EVENTS

Required Entries

RESOURCE-DISAGGREGATION

Dimensional Format

This is a required data item for a thinker that has subordinates that are modelled as future players. It associates the names of the future player subordinates with the names of the resulting player types once the subordinate has been 'disaggregated'. The command has just one list whose **DIMENSION** statement is labelled with the keyword **RESOURCE-TYPE**. The entries have the following syntax:

RESOURCE-TYPE is the name of the subordinate which is selected from the list of future players in the UAN

CREATED-PLAYER which is the name of the created player's type selected from the list of players in the UAN. One such identification should occur for each subordinate name.

TIME-BEFORE-DROP

One-line Format

Refers to the amount of time a perception from a sensor can be kept before it is dropped. There are two entries: a time delay given as a positive real number and units which are one of **(SEC)**, **(MIN)** or **(HR)**. A perception can last somewhat longer than this, the delay being in practice the minimum amount of time before it is dropped.

TIME-TO-THINK

Block Format

This data item specifies how long each thinker will take to think about specific events. Each entry consists of a thinking time from the table below, a delay <time> which is a positive real number and units for the time which are one of **(MILLISEC)**, **(SEC)**, **(MIN)** or **(HR)**. The table below lists the various thinking times, that can be specified, along with their function. Notice that if an appropriate thinking time is not defined for a thinker, that thinker cannot be employed to consider the related actions. For example, if the **EVAL-FIRING** time were absent the thinker would not be able to consider the firing of weapons as described in the player's lethal engagement tactics.

The Type Data Base

Thinker Capabilities

Thinking Time	Corresponding Decision
ASSIMILATE-INTELL	Assimilating sensor output from three RECOG options in this table
CONSIDER-ASG/CANCEL	Thinking about making an assignment or cancelling it
CONSIDER-LAUNCH	Thinking about launching a subordinate
CONSIDER-MOVE	Thinking about reactive movement
EVAL-ASSIGN-THREAT	Considering the addition or deletion of a target to the list of assignable targets
EVAL-EMCON-CHANGE	Evaluate turning sensors on or off for emission control
EVAL-ENGAGE-THREAT	Considering the addition or deletion of a target to the list of engageable targets
EVAL-FIRING	Thinking about starting or stopping firing
EVAL-GUNS-FREE/TIGHT	Thinking about changing the lethal mode of control for subordinates
EVAL-JMR-QUEUE	Thinking about adding or dropping a perceived emitter to the list of disruptable targets
EVAL-JMR-SPOTS	Thinking about starting or stopping jamming
EVAL-LETHAL-ENGAGE	Thinking about starting or stopping engaging
RECOG-MSG	Recognising the receipt or non-receipt of a message
RECOG-PHYS-EVENT	Sensing an attack on a player
RECOG-SNR-EVENT	Recognising results of a sensor
REVIEW-INFORMATION	Reviewing information

Any combination of the above options can be used depending upon the type of thinker system. All systems need **REVIEW-INFORMATION**. The following example illustrates one usage:

If a player can move as a result of either a physical stimulus or received intelligence it would have a minimum of the following options:

ASSIMILATE-INTELL
 CONSIDER-MOVE
 RECOG-MSG
 RECOG-SNR-EVENT
 REVIEW-INFORMATION

Optional Entries**MAX-CONCURRENT-EVENTS**One-line Format

This places a limit on how many events a thinker system can consider at once. The entries are the limiting number of events, given as a positive integer, and qualified with the keyword (**NO-UNITS**). If this item is omitted the default is a limit of one event.

1.4.4. Communication Receiver

Required:

ANTENNA-PATTERN
RCVR-NOISE

RCVR-BANDWIDTH
RECOGNITION-THRESH

Optional:

COMM-JMR-INTERACTIONS
J/N-COMM-OPERATOR-THRESHOLD
TRANSMISSION-LOSS

EFFECTIVE-EARTH-RADIUS
POLARIZATION-EFFECTS
VERTICAL-OFFSET

Required Entries

ANTENNA-PATTERN

Dimensional Format

Energy is not received nor transmitted uniformly in all directions by a radio antenna, instead the antenna will have a different efficiency in different directions. This data item allows representation of different types of antenna patterns. The format is tabular with two **DIMENSION** statements, labelled by **AZ** and **EL**, describing the antenna's azimuthal and elevation dependence respectively. The effectiveness of the antenna is expressed by its **GAIN**, in units of (DB), which gives the ratio between the energy that is focused in that angular range by the antenna and the amount of energy that would be focused in that region by a perfectly uniform antenna pattern. So if the antenna channels 100 times as much energy in a certain direction than a uniform antenna would, then its gain would be 20 dB.

Label	Allowed Units	Form of Entry
AZ	(DEG) or (RADIANS)	Real number in the range $[0.0^{\circ} \rightarrow 180.0^{\circ}]$ or $[0.0 \rightarrow \pi]$
EL	(DEG) or (RADIANS)	Real number in the range $[-90.0^{\circ} \rightarrow 90.0^{\circ}]$ or $[-\pi/2 \rightarrow \pi/2]$
GAIN	(DB)	Real number

There is an assumed left-right symmetry in azimuth, but no up-down symmetry in elevation.

RCVR-BANDWIDTH

One-line Format

Required for communication receivers if they are used on explicit communication nets. It defines the frequency response of a receiver. The input is the receiver's bandwidth, given as a positive real number with units of (HZ), (KHZ), (MHZ) or (GHZ).

RCVR-NOISE

One-line Format

Required for communication receivers if they are used on explicit nets. It represents the amount of background noise intrinsic to the receiver. The input is the receiver noise specified as a positive real number with units of (WATTS).

The Type Data Base

Communication Receiver Capabilities

RECOGNITION-THRESHOne-line Format

Required for communication receivers if they are used on explicit communication nets. It describes the minimum ratio between received signal power and noise plus jamming power required for messages to be recognized. The input is the recognition threshold given as a real number with units of (DB).

Optional Entries**EFFECTIVE-EARTH-RADIUS**One-line Format

Allows the curvature of the Earth and the refraction of electromagnetic radiation by the atmosphere to be taken into account in a Suppressor scenario. If this data item is omitted, calculations use a flat Earth. The entries are the radius, a positive real number, with units selected from (M), (KM), (FT) or (MILES).

COMM-JMR-INTERACTIONSName Format

Required if the receiver can be jammed. The entry is a list of names, selected from the list of disruptors in the UAN, of all the explicit disruptors that might affect the particular communication receiver.

J/N-COMM-OPERATOR-THRESHOLDOne-line Format

Allows the communications receiver operator to sense the presence of jamming directed against the receiver. For this to occur the noise jamming signal must exceed the receiver noise signal (RCVR-NOISE) by the threshold specified by this command. If omitted, the default value for the J/N-COMM-OPERATOR-THRESHOLD is 380 dB. When this threshold is exceeded the alternative frequencies listed in the SDB for this communication receiver can be used. The inputs are a real number representing the threshold with units of (DB).

POLARIZATION-EFFECTSBlock Format

This data item provides a set of factors which either attenuate or magnify the power received from a jammer to take into account the receiver's capabilities to detect polarized signals. It is an optional entry for communication receivers that can be affected by a disruptor system. The input has the following required entries:

HORIZONTAL

VERTICAL

LEFT-CIRCULAR

RIGHT-CIRCULAR

Each is followed by a non-negative real multiplier with units specified as (NO-UNITS). Each factor ranges between zero and one for attenuation and greater than one for magnification. If disruptors are present in the scenario and this data item is absent then the default multiplicative factor is unity. These characteristics to have a meaning the DISRUPTOR-CHARACTERISTICS must allow the relevant jammers to transmit polarized signals.

TRANSMISSION-LOSS

Dimensional Format

Describes any type of transmission loss of signal strength due to its transmission through an atmosphere. The input has four lists with **DIMENSION** statements labelled with the entries below:

FREQ the frequencies of the transmitted signals, with at least two frequency values are required. These values are positive real numbers with units chosen from **(HZ)**, **(KHZ)**, **(MHZ)** or **(GHZ)**.

ALT-XMIT specifies altitude intervals for the transmitter using real number with units of **(M)**, **(KM)**, **(FT)**, **(MILES)** or **(ANGELS)**.

ALT-RCVR specifies altitude intervals for the receiver using real number with units of **(M)**, **(KM)**, **(FT)**, **(MILES)** or **(ANGELS)**.

2D-DIST denotes the intervals of projected surface distance between transmitter and receiver given as a non-negative real number with units selected from **(M)**, **(KM)**, **(FT)** or **(MILES)**.

GAIN this occurs once for each distance interval and specifies the gain achieved by the signal in travelling from the transmitter to the receiver as a real number with units of **(DB)**. Positive real numbers are used to represent gains and negative real numbers losses, in practice losses would be recorded for realistic models.

If this data item is absent then the default gain value is zero. Note that the transmitter and receiver are treated symmetrically in this table, so entries should also be symmetric. That is to say, the losses between a transmitter at an altitude of 1 km and a receiver at ground level should be the same as the losses between a receiver at 1 km and a transmitter at ground level if they are the same distance apart.

VERTICAL-OFFSET

One-line Format

Defines the vertical offset of the antenna in relation to the altitude of the element carrying the antenna. It is recommended that this data item is included especially for antenna situated at or near ground level. The input has the entries of antenna height, a real number, and units of either **(M)**, **(KM)**, **(FT)** or **(MILES)**. The default value is that the antenna is not offset from the element carrying it.

The Type Data Base

Communication Transmitter Capabilities

1.4.5. Communication Transmitter

Required:

ANTENNA-PATTERN

XMTR-BANDWIDTH

XMTR-POWER

Optional:

EFFECTIVE-EARTH-RADIUS

INTERCEPT-INTERACT

VERTICAL-OFFSET

Required Entries**ANTENNA-PATTERN**Dimensional Format

Energy is not received nor transmitted uniformly in all directions by a radio antenna, instead the antenna will have a different efficiency in different directions. This data item allows representation of different types of antenna patterns. The format is tabular with two **DIMENSION** statements, labelled by **AZ** and **EL**, describing the antenna's azimuthal and elevation dependence, respectively. The effectiveness of the antenna is expressed by its **GAIN**, in units of **(DB)**, which gives the ratio between the energy that is focused in that angular range by the antenna and the amount of energy that would be focused in that region by a perfectly uniform antenna pattern. So if the antenna channels 100 times as much energy in a certain direction than a uniform antenna would, then its gain would be 20 dB.

Label	Allowed Units	Form of Entry
AZ	(DEG) or (RADIANS)	Real number in the range $[0.0^\circ \rightarrow 180.0^\circ]$ or $[0.0 \rightarrow \pi]$
EL	(DEG) or (RADIANS)	Real number in the range $[-90.0^\circ \rightarrow 90.0^\circ]$ or $[-\pi/2 \rightarrow \pi/2]$
GAIN	(DB)	Real number

There is an assumed left-right symmetry in azimuth, but no up-down symmetry in elevation.

XMTR-BANDWIDTHOne-line Format

Required for communication transmitters that are used on explicit communication nets. This entry specifies the frequency bandwidth of a communication transmitter. The input is the bandwidth given as a positive real number, with units of **(HZ)**, **(KHZ)**, **(MHZ)** or **(GHZ)**.

XMTR-POWEROne-line Format

Required for communication transmitters that are used on explicit communication nets. It specifies the amount of power that a communication transmitter is capable of radiating. The power output is specified by a positive real number in units of **(WATTS)**.

Optional Entries**EFFECTIVE-EARTH-RADIUS**One-line Format

Allows the curvature of the Earth and the refraction of electromagnetic radiation by the atmosphere to be taken into account in a Suppressor scenario. If this data item is omitted calculations use a flat Earth. The entries are the radius, a positive real number, with units selected from (M), (KM), (FT) or (MILES).

INTERCEPT-INTERACTName Format

This data item enables a warning receiver to pick up emissions from the communication transmitter. The input is the name of one or more warning receivers, which must also appear in the **SNR-ELE-INTERACTIONS** of the element which owns the communication transmitter. The warning receiver names are from the list of sensor receivers in the UAN.

VERTICAL-OFFSETOne-line Format

Defines the vertical offset of the antenna in relation to the altitude of the element carrying the antenna. It is recommended that this data item is included especially for antenna situated at or near ground level. The input has the entries of antenna height, a real number, and units of either (M), (KM), (FT) or (MILES). The default value is that the antenna is not offset from the element carrying it.

The Type Data Base

Disruptor Capabilities

1.4.6. Disruptor

Required:

DISRUPTOR-CHARACTERISTICS	DISRUPTOR-FREQ-LIMITS
MAX-POWER-OUT	MAX-RNG

Optional:

ANTENNA-PATTERN	EFFECTIVE-EARTH-RADIUS
LAMBDA-PATTERN	INTERNAL-LOSS
MAX-NO-SPOTS	SINE-PATTERN
TIME-REACT-FREQ-DELAY	TRANSMISSION-LOSS
VERTICAL-OFFSET	

Required Entries**DISRUPTOR-CHARACTERISTICS**Option Format

This required item describes the characteristics of the disruptor using five sets of options. Of these options, which are listed below, the first two, Model Detail and Active or Passive are always required.

Model Detail

The level of detail at which the disruptor is modelled. This is set as one of:

IMPLICIT-DETAIL is for disruptors which are not physically modelled, such as are used when modelling chaff, flares or in some cases jammers. In this case, the only influence of the disruptor is via the **WPN-PK** and **WPN-TIME-DELAYS** of the targetted players.

EXPLICIT-DETAIL is for disruptors whose operation is directly modelled. This applies to disruptors emitting energy in the radio frequency bands, such as jammers. With these disruptors the amount of energy received at a communication or sensor receiver, which stemmed from the disruptor, can be precisely computed.

Active or Passive

This entry also identifies the type of disruptor, there are two options which are:

ACTIVE which is used for explicitly modelled communication and radar receiver jammers that emit energy in the RF bands.

PASSIVE which is used for other types of jammers whose emissions are not explicitly modelled. All **IMPLICIT-DETAIL** disruptors will also be defined as **PASSIVE**.

Operation Mode

This is required if the disruptor is modelled using **EXPLICIT-DETAIL**.

NOISE for modelling jammer systems which operate by trying to jam signals.

In particular, by trying to create excessive noise to swamp the signals received by communication and sensor receivers.

PULSE for modelling jammers which concentrate power into narrow pulses in an attempt to create phoney returns for sensor receivers. These use less power than **NOISE** mode disruptors, but are not effective against communication receivers.

Power distribution

This is required if the **PULSE** operation mode, described above, is chosen and it describes the 'spots' of frequency in which the jammer will broadcast its output pulses. The choice of settings are:

CONST-PWR/SPOT indicating that each spot has a constant power, which is specified with **MAX-POWER-OUT**.

AVG-PWR/SPOT indicating the jammer power is divided among the spots, and the total power, **MAX-POWER-OUT**, is the sum of powers from all spots.

Polarization

This refers to four types of polarization mismatch that can contribute to loss of the jammer power signal and is only required if **ACTIVE** and **EXPLICIT** are chosen. The options are one of the four types of polarization:

VERT-POL, **HORIZ-POL**, **LEFT-CIR-POL** or **RIGHT-CIR-POL**.

DISRUPTOR-FREQ-LIMITS

Block Format

Required for active-explicit disruptors. This defines the limits on the disruptor frequency using the inputs described in the table below. The first two are required:

Entry	Description
LOWER-FREQ-LIMIT	The lower limit of the jammers frequency range.
UPPER-FREQ-LIMIT	The upper limit of the jammers frequency range.
SPOT-SIZE-BANDWIDTH	Used in conjunction with non-lethal engagement tactics to set the bandwidths of its focused spots.
SUBCARRIER BANDWIDTH	Used with PULSE mode jammers to define the bandwidth of the sub-carriers which make up each spot.

All the entries are positive real number with units chosen from (HZ), (KHZ), (MHZ) or (GHZ) .

MAX-POWER-OUT

One-line Format

Required for active-explicit disruptors. It defines the maximum transmitted power of a jammer. The output power is a positive real number measured in (WATTS). The model uses this power value to calculate effective received power at the sensor or communication receiver.

The Type Data Base

Disruptor Capabilities

MAX - RNGOne-line Format

Required for active-explicit disruptors that affect communication or sensor receivers. Defines the maximum effective range of a disruptor. The inputs are the range given as a positive real number, with units of (M), (KM), (FT) or (MILES).

Optional Entries

The following entries are only relevant for explicitly modelled active disruptors:

ANTENNA - PATTERNDimensional Format

Energy is not received nor transmitted uniformly in all directions by a radio antenna, instead the antenna will have a different efficiency in different directions. This data item allows representation of different types of antenna patterns. The format is tabular with two **DIMENSION** statements, labelled by **AZ** and **EL**, describing the antenna's azimuthal and elevation dependence, respectively. The effectiveness of the antenna is expressed by its **GAIN**, in units of (DB), which gives the ratio between the energy that is focused in that angular range by the antenna and the amount of energy that would be focused in that region by a perfectly uniform antenna pattern. So if the antenna channels 100 times as much energy in a certain direction than a uniform antenna would, then its gain would be 20 dB.

Label	Allowed Units	Form of Entry
AZ	(DEG) or (RADIANS)	Real number in the range $[0.0^\circ \rightarrow 180.0^\circ]$ or $[0.0 \rightarrow \pi]$
EL	(DEG) or (RADIANS)	Real number in the range $[-90.0^\circ \rightarrow 90.0^\circ]$ or $[-\pi/2 \rightarrow \pi/2]$
GAIN	(DB)	Real number

There is an assumed left-right symmetry in azimuth, but no up-down symmetry in elevation.

EFFECTIVE - EARTH - RADIUSOne-line Format

Allows the curvature of the Earth and the refraction of electromagnetic radiation by the atmosphere to be taken into account in a Suppressor scenario. If this data item is omitted calculations use a flat Earth. The entries are the radius, a positive real number, with units selected from (M), (KM), (FT) or (MILES).

INTERNAL - LOSSOne-line Format

Describes the losses to a signal which occur due to the disruptor's internal operation. The input is the internal losses specified as a real number measured in (DB). The default is zero and for realistic systems will be negative since positive numbers represent gains and negative numbers losses. The entry represents the disruptor's efficiency in transmitting its power output.

LAMBDA-PATTERN

Block Format

This entry is an alternative to the use of **ANTENNA-PATTERN**. It allows an antenna having a 'sine pattern', $(\sin x/x)^2$, to be defined using just three entries. It is appropriate for circular antennae with uniform illumination. The first two entries are real numbers specifying the gains of the pattern in (DB):

PEAK-GAIN is the maximum gain of the antenna pattern, and

MIN-GAIN is the minimum gain of the antenna pattern.

The final entry is the beamwidth of the antenna specified as a positive real number with units of (DEG) or (RADIANS):

BEAMWIDTH is the beamwidth of the antenna pattern, i.e. the angular width of the pattern at its half power (-3dB) points.

If **LAMBDA-PATTERN** is given in addition to **ANTENNA-PATTERN** then the **LAMBDA-PATTERN** entry will be used to define the antenna pattern.

MAX-NO-SPOTS

One-line Format

Defines the maximum number of different frequency bands that can be focused on targets at the same time. The input is a positive integer followed by the keyword (NO-UNITS).

SINE-PATTERN

Block Format

This entry is an alternative to the use of an **ANTENNA-PATTERN**. It allows an antenna having a 'sine pattern', $(\sin x/x)^2$, to be defined using just five entries. It is appropriate for rectangular or elliptical antennae with uniform illumination. The first two entries specify the gains of the pattern in (DB):

PEAK-GAIN is the maximum gain of the antenna pattern,

MIN-GAIN is the maximum gain of the antenna pattern,

The next two entries specify the pattern's beamwidths as positive real numbers with units of either (DEG) or (RADIANS):

AZ-BEAMWIDTH is the beamwidth of the antenna pattern in the azimuth plane,

EL-BEAMWIDTH is the beamwidth of the antenna pattern in the elevation plane,

With a final entry being used to alter the direction of the antenna's boresight in elevation through an angle measured in either (DEG) or (RADIANS):

EL-BORESIGHT-ANGLE is used to incline the boresight of the pattern either up through a positive angle or down through a negative angle given as a real number. The input is a real number with units as either (DEG) or (RADIANS).

If **SINE-PATTERN** is given in addition to **ANTENNA-PATTERN** then the **SINE-PATTERN** entry will be used to define the antenna pattern.

The Type Data Base

Disruptor Capabilities

TIME-REACT-FREQ-CHANGEOne-line Format

Defines the time taken for a jammer to adjust the frequencies of any spots directed at an emitter that itself changes frequency. The inputs are the time delay given as a non-negative real number with units chosen from either (SEC), (MIN) or (HR).

TRANSMISSION-LOSSDimensional Format

Describes any type of transmission loss over and above the loss of signal strength due to its transmission through an atmosphere. The input has four dimensions corresponding to the entries below:

FREQ At least two frequency values are required. These values are positive real numbers with units as (HZ), (KHZ), (MHZ) or (GHZ).

ALT-XMIT Gives the altitude for the transmitter as a real number with units as (M), (KM), (FT), (MILES) or (ANGELS).

ALT-RCVR Gives the altitude for the receiver as a real number with units as (M), (KM), (FT), (MILES) or (ANGELS).

2D-DIST Denotes the two dimensional distance interval between two objects given as a non-negative real number with units as (M), (KM), (FT) or (MILES).

GAIN This occurs once for each 2D-distance interval as a real number with units (DB). Positive real numbers are used to represent gains and negative real numbers losses.

If this data item is absent then the default gain value is zero. Note that the transmitter and receiver are treated symmetrically in this table, so entries should be consistent with this fact.

VERTICAL-OFFSETOne-line Format

Defines the vertical offset of the antenna in relation to the altitude of the element carrying the antenna. It is recommended that this data item is included especially for antenna situated at or near ground level. The input has the entries of antenna height, a real number, and units of either (M), (KM), (FT) or (MILES). The default value is that the antenna is not offset from the element carrying it.

1.4.7. Sensor Transmitter

Required:

PEAK-POWER-OUTPUT

XMIT-FREQ

Optional:

ANTENNA-PATTERN

ANTGR-PATTERN

AZIMUTH-SLEW-LIMITS

CHANGE-FREQUENCY-DELAY

COSECANT-PATTERN

DUTY-CYCLE

EFFECTIVE-EARTH-RADIUS

ELEV-SLEW-LIMITS

INTERCEPT-INTERACT

INTERNAL-LOSS

LAMBDA-PATTERN

MIN-GAIN (RWR-BACKLOBE-GAIN)

PEAK-GAIN

PULSE-COMPRESSION-RATIO

PULSE-REPETITION-FREQUENCY

SINE-PATTERN

VERTICAL-OFFSET

Required

PEAK-POWER-OUTPUT

One-line Format

Defines the amount of power that a sensor transmitter will emit. The power is given as a positive real number with units of (WATTS).

XMIT-FREQ

One-line Format

Specifies the frequency band used by the sensor transmitter. It is the default operating frequency if no frequencies are defined in the SDB using the FREQ: statement. The frequency is given as a positive real number with units of (HZ), (KHZ), (MHZ) or (GHZ).

Optional

ANTENNA-PATTERN

Dimensional Format

Energy is not received nor transmitted uniformly in all directions by a radio antenna, instead the antenna will have a different efficiency in different directions. This data item allows representation of different types of antenna patterns. The format is tabular with two DIMENSION statements, labelled by AZ and EL, describing the antenna's azimuthal and elevation dependence, respectively. The effectiveness of the antenna is expressed by its GAIN, in units of (DB), which gives the ratio between the energy that is focused in that angular range by the antenna and the amount of energy that would be focused in that region by a perfectly uniform antenna pattern. So if the antenna channels 100 times as much energy in a certain direction than a uniform antenna would, then its gain would be 20 dB.

The Type Data Base

Sensor Transmitter Capabilities

Label	Allowed Units	Form of Entry
AZ	(DEG) or (RADIANS)	Real number in the range $[0.0^\circ \rightarrow 180.0^\circ]$ or $[0.0 \rightarrow \pi]$
EL	(DEG) or (RADIANS)	Real number in the range $[-90.0^\circ \rightarrow 90.0^\circ]$ or $[-\pi/2 \rightarrow \pi/2]$
GAIN	(DB)	Real number

There is an assumed left-right symmetry in azimuth, but no up-down symmetry in elevation.

ANTGR-PATTERNDimensional Format

An alternative to **ANTENNA-PATTERN** for sensor transmitters. It defines the parameters which specify an antenna pattern using built in tables. There are four required inputs:

PATTERN-ID identifies the antenna pattern number. This is entered as a real number with **(NO-UNITS)**. Since the pattern numbers are contained in an unavailable US document this command is not really useful for non-US users.

GAIN-CORRECTION is an amplitude adjustment value entered as a real number with units of **(DB)**. This adjustment is added to each gain value.

MIN-GAIN is the minimum gain value for this antenna also entered as a real number with units of **(DB)**.

EL-ROTATION is used to rotate the pattern in elevation, either up with a positive real number or down with a negative real number. These have units of either **(DEG)** or **(RADIANS)**.

AZIMUTH-SLEW-LIMITSBlock Format

This data item provides a way to represent the left and right physical slewing limits of an antenna, if this data item is omitted the sensor can slew to point in any direction. The azimuth slew limits are relative to the heading of the location which includes the sensor transmitter. The heading for a moving location is aligned with its velocity vector and the heading for a stationary location can be assigned using **HDG:** in the **SDB LOC:** sentences, or changed dynamically using **WITH-TGT-CUING** or **WITH-SDB-CUING** phrases in the resource allocation. There are two required inputs **LEFT-AZ:** and **RIGHT-AZ:** each one being followed by a positive real number for an azimuth angle from the range $[0 \rightarrow \pi]$ or $[0.0 \rightarrow 180.0]$ with units of either **(RADIANS)** or **(DEG)**.

CHANGE-FREQUENCY-DELAYOne-line Format

This data item defines the time required by a transmitter to change to an alternative frequency in order to avoid a jamming signal. The delay is given as a positive real number with units of **(SEC)**, **(MIN)** or **(HR)**. Alternative frequencies are used only if these are defined in the SDB and the jamming signal exceeds all other noise by the relevant **J/N-NOISE-OPERATOR-THRESHOLD** or **J/N-PULSE-OPERATOR-**

THRESHOLD as defined in the **DETECTION-SENSITIVITIES** of the linked radar receiver. If no delay is defined for the use of the alternative frequencies the frequency change is assumed to be instantaneous.

COSECANT-PATTERN

Dimensional Format

This entry is an alternative to the use of an **ANTENNA-PATTERN**. It allows an antenna having a cosecant squared pattern to be defined using just six entries. Cosecant squared antennae are designed to maintain a constant return from a target which is approaching at a constant altitude. The maximum and minimum gains of the antenna are specified in units of (DB) using the items:

PEAK-GAIN is the maximum gain of the antenna pattern

MIN-GAIN is the minimum gain of the antenna pattern

These are followed by the pattern's azimuthal beamwidth:

AZ-BEAMWIDTH is the beamwidth of the antenna pattern in the azimuthal plane

In elevation three angles must be specified to fully describe the antenna's gain:

MIN-EL-FOR-PEAK-GAIN is the minimum elevation at which the gain of the antenna pattern has the value **PEAK-GAIN**. At elevations less than this value the gain of the antenna is specified by the **MIN-GAIN**.

PEAK/CSC2-BOUNDARY-EL is the elevation angle which divides the part of the antenna pattern which has **PEAK-GAIN** from the cosecant squared portion of the pattern. This is the lower boundary of the cosecant squared portion of the antenna pattern.

MAX-EL-FOR-CSC2 is the upper limit of the cosecant squared portion of the antenna pattern. At elevation angles greater than this angle the antenna's gain is again specified with **MIN-GAIN**.

The above angles should be specified as positive real numbers with units of (DEG) or (RADIAN). If **COSECANT-PATTERN** is used in addition to either **ANTENNA-PATTERN** or **ANTGR-PATTERN** then the **COSECANT-PATTERN** entry will be used.

DUTY-CYCLE

One-line Format

This data item specifies, along with **PULSE-COMPRESSION-RATIO**, the fraction of time that a radar transmitter is emitting. It is used to describe pulsed Doppler radars. The entry is a positive real number with (NO-UNITS). This value should lie between zero and one. The default value is unity. Notice that if the transmitter is always turned on then a radar receiver would never be able to detect any signals if it shared the same antenna. If pulse compression is also in use then this value is actually not the fractional amount of time that the transmitter is turned on but rather this quantity divided by the degree of pulse compression. So if the quantity specified by the **DUTY-CYCLE** entry is d and the pulse compression is p then the fraction of time that a transmitter is in operation δ is given as $\delta = d p$.

The Type Data Base

Sensor Transmitter Capabilities

ELEV-SLEW-LIMITSBlock Format

This data item defines the elevation limits within which the antenna can slew to point at a target. It is only relevant for sensors defined as **FREQ-DRIVEN** in their **SNR-CHARACTERISTICS**. **PHYSICAL-SCAN** sensors cannot slew in elevation at all. When omitted **FREQ-DRIVEN** sensors have no limits placed on their ability to slew in elevation. There are two entries:

MAX-EL is the maximum elevation angle

MIN-EL is the minimum elevation angle

Both entries are followed by a real number for an elevation angle with units chosen from either (**RADIANS**) or (**DEG**).

EFFECTIVE-EARTH-RADIUSOne-line Format

Allows the curvature of the Earth and the refraction of electromagnetic radiation by the atmosphere to be taken into account in a Suppressor scenario. If this data item is omitted calculations use a flat Earth. The entries are the radius, a positive real number, with units selected from (**M**), (**KM**), (**FT**) or (**MILES**).

INTERCEPT-INTERACTName Format

This data item enables a warning receiver to pick up emissions from the sensor transmitter. The input is the name of one or more warning receivers, which must also appear in the **SNR-ELE-INTERACTIONS** of the element which owns the communication transmitter. The warning receiver names are from the list of sensor receivers in the UAN.

INTERNAL-LOSSOne-line Format

Describes the losses to a signal which occur due to the transmitter's internal operation. The input is the internal losses specified as a real number measured in (**DB**). The default is zero and for realistic systems will be negative since positive numbers represent gains and negative numbers losses. The entry represents the transmitter's efficiency in transmitting its power output.

LAMBDA-PATTERNBlock Format

This entry is an alternative to the use of an **ANTENNA-PATTERN**. It allows an antenna having a 'sine pattern', $(\sin x/x)^2$, to be defined using just three entries. It is appropriate for circular antennae with uniform illumination. The first two entries are real numbers specifying the gains of the pattern in (**DB**):

PEAK-GAIN is the maximum gain of the antenna pattern.

MIN-GAIN is the minimum gain of the antenna pattern.

The final entry is the beamwidth of the antenna specified as a positive real number with units of (**DEG**) or (**RADIANS**).

BEAMWIDTH is the beamwidth of the antenna pattern. i.e. the angular width of the pattern at its half power (-3dB) points.

If **LAMBDA-PATTERN** is given in addition to either **ANTENNA-PATTERN** or **ANTGR-PATTERN** then the **LAMBDA-PATTERN** entry will be used to define the antenna pattern.

MIN-GAIN

RWR-BACKLOBE-GAIN

One-line Format

Defines the minimum gain emitted on the transmitter's backlobes. If the transmitter can be detected by a warning receiver which can detect backlobe emissions then this item defines the backlobe gain that is used to determine if the warning receiver can detect the transmitter. The gain is given as a real number measured in (DB).

PEAK-GAIN

One-line Format

This entry defines the maximum gain of the antenna used by the sensor transmitter. It is a required entry when used in conjunction with **ANTENNA-PATTERN** and **ONE-M2-DETECT-RNG** for a radar receiver, since it is used to calibrate the radar's range. It may be omitted when the antenna pattern is defined with **COSECANT-PATTERN**, **LAMBDA-PATTERN** or **SINE-PATTERN** since these entries already incorporate a **PEAK-GAIN** item.

PULSE-COMPRESSSION-RATIO

One-line Format

Defines the pulse compression ratio for a sensor transmitter. The ratio is entered as a positive real number with units of (DB). When omitted the default ratio is unity. This entry is used in conjunction with **DUTY-CYCLE** to determine the duty cycle of the transmitter.

PULSE-REPETITION-FREQUENCY

One-line Format

Defines the rate at which a sensor transmitter emits pulses of energy. This data item is required for sensor transmitters linked to radar receivers that model MTI (moving target indicator) effects on received signals. The frequency is specified by a positive real number with units from (HZ), (KHZ), (MHZ) or (GHZ).

SINE-PATTERN

Block Format

This entry is an alternative to the use of an **ANTENNA-PATTERN**. It allows an antenna having a 'sine pattern', $(\sin x/x)^2$, to be defined using just five entries. It is appropriate for rectangular or elliptical antennae with uniform illumination. The first two entries specify the gains of the pattern in (DB):

PEAK-GAIN is the maximum gain of the antenna pattern,

MIN-GAIN is the minimum gain of the antenna pattern,

The next two entries specify the pattern's beamwidths as positive real numbers with units of either (DEG) or (RADIANS):

AZ-BEAMWIDTH is the beamwidth of the antenna pattern in the azimuth plane,

EL-BEAMWIDTH is the beamwidth of the antenna pattern in the elevation plane,

With a final entry being used to alter the direction of the antenna's boresight in elevation through an angle measured in either (DEG) or (RADIANS):

The Type Data Base

Sensor Transmitter Capabilities

EL-BORESIGHT-ANGLE is used to incline the boresight of the pattern either up through a positive angle or down through a negative angle given as a real number. The input is a real number with units as either **(DEG)** or **(RADIANS)**.

If **SINE-PATTERN** is given in addition to either **ANTENNA-PATTERN** or **ANTGR-PATTERN** then the **SINE-PATTERN** entry will be used to define the antenna pattern.

VERTICAL-OFFSETOne-line Format

Defines the vertical offset of the antenna in relation to the altitude of the element carrying the antenna. It is recommended that this data item is included especially for antenna situated at or near ground level. The input has the entries of antenna height, a real number, and units of either **(M)**, **(KM)**, **(FT)** or **(MILES)**. The default value is that the antenna is not offset from the element carrying it.

1.4.8. Sensor Receiver

SENSOR RECEIVERS

There are four types of sensor receivers that can be modelled with Suppressor: optical, infra-red, radar warning receivers and radars. Those data that are appropriate to all types of sensor receivers are discussed here, with those specific to individual varieties of sensor receiver being listed later.

Required

SNR-CHARACTERISTICS
QUALITY-OF-DATA
SENSING-MODE-RATES

DETECTION-SENSITIVITIES
RNG-ALT-CAPABILITY

Optional

AZIMUTH-SLEW-LIMITS	EFF-BURST-CM-PROB
EFFECTIVE-EARTH-RADIUS	ELEV-SLEW-LIMITS
HITS-TO-ESTABLISH-TRACK	HITS-TO-ESTABLISH-TRACK-(JAM)
IMPLICIT-CM-INTERACT	MAX-PARALLEL-TRACKS
POLARIZATION-EFFECTS	SCANS-IN-ESTABLISHING-TRACK-(DRY)
SCANS-IN-ESTABLISHING-TRACK-(JAM)	SEEKER-ERROR-DATA
SNR-ANGULAR-LIMITS	SNR-DOPPLER-LIMITS
SNR-TIME-DELAYS	SNR-TRACKING-PROBABILITIES
TRANSMISSION-LOSS	VERTICAL-OFFSET

All Sensor ReceiversRequiredSNR-CHARACTERISTICSOption Format

Describes characteristics of a sensor receiver through the use of the six entries described below, each has a set of options with the default values underlined:

Scan Plane

This defines the plane in which the sensor receiver scans. It has two options:

PHYSICAL-SCAN, used for sensor receivers that do not tilt in elevation,
FREQ-DRIVEN, these sensors can tilt in elevation as well as scan in azimuth

Search Mode

Defines how a sensor receiver is used. It has three options:

ACQ, TRK, BOTH-ACQ/TRK,

used respectively for acquisition, tracking or both acquisition and tracking. Any mode set in this table must have a corresponding rate entered through the **SENSING-MODE-RATES** data item. If a sensor has a mode of **TRK** or **BOTH-ACQ/TRK** there should be a weapon linked with this sensor in the **PLAYER-STRUCTURE**.

IFF indicator

Defines whether or not the sensor receiver can determine if a target is a friend or foe. It has two options:

The Type Data Base

Sensor Receiver Capabilities

IFF and NO-IFF.

Sensor Type

Specifies the general type of the sensor receiver described by the four options:

RADAR, INFRA-RED, OPTICAL, WARNING-RCVR.

Polarization

Only used if this sensor is used to detect targets with polarization dependent detection cross-sections. Polarization is one of the following:

HORIZ-POL, VERT-POL, LEFT-CIR-POL, RIGHT-CIR-POL.

If polarization is omitted then the DEFAULT entry in the RCS-TABLE is used.

Acquire when Tracking Mode

This entry defines whether a sensor with a BOTH-ACQ/TRACK mode is able to acquire other targets while it is tracking one or more primary targets. There are two options: ACQ-WHEN-TRK which allows acquisition when the sensor is in tracking mode, or NO-ACQ-WHEN-TRK which allows acquisitions of new targets only when the sensor is not tracking.

DETECTION-SENSITIVITIESBlock Format

Defines the capability of sensors to detect targets. The format varies from one sensor receiver to another and is given in detail for each sensor receiver separately.

QUALITY-OF-DATAName Format

Represents how the sensor receiver performs its functions by specifying what information can be deduced from returned sensor information. Eight options can be specified which are as follows:

ALT The altitude of the target

PLANAR-LOCATION The target's position

AZ The target's azimuth

HEADING The current heading of the target

NO-OF-ELEMENTS The number of elements at the target's location

SPD The speed of the target

TYPE-OF-ELEMENT The type of element that constitutes the target

TYPE-OF-PLAYER The player-type of the target

The first two of these are required for correct operation of Suppressor, ALT and PLANAR-LOCATION. Most of the rest will often be necessary for correct evaluation of the player's tactics.

RNG-ALT-CAPABILITYDimensional Format

This is used as a filter to determine whether or not further calculations for sensor chances should be carried out. The data is in a table with a single DIMENSION statement labelled with the keyword RNG which gives a list of range intervals. For each

range interval a pair of limiting altitudes are listed, **MIN-ALT** and **MAX-ALT**. These altitudes are measured with respect to the position of the sensor and indicate the bounds within which targets may be perceived. The format is as shown below:

```
RNG-ALT-CAPABILITY
  DIMENSION 1 RNG <range units>
    <range> <range> ...
  MIN-ALT <altitude units> MAX-ALT <altitude units>
    <min-alt> <max-alt>
.
END RNG-ALT-CAPABILITY
```

The units for range can be **(M)**, **(KM)**, **(FT)** or **(MILES)** and the units for altitude, which may differ, can be chosen from **(M)**, **(KM)**, **(FT)**, **(MILES)** or **(ANGELS)**. All entries are specified real numbers.

SENSING-MODE-RATES

Block Format

Defines how often a sensor receiver is able to detect a target. There are four possible entries:

```
ACQ-SENSING-RATE
TRACK-SENSING-RATE
FIRING-SENSING-RATE
REACQUISITION-TIME
```

These are used in combinations which depend upon the function of the sensor, so that for example an tracking sensor will require at least the **TRACK-SENSING-RATE** and on. Each rate specification is given as a positive real number with units of **(1/SEC)**. In general, the rate for firing is greater than the rate for tracking which is greater than the rate for acquiring.

The entry **REACQUISITION-TIME** is not a rate at all and can be used for optical sensor receivers only. It specifies how long an optical sensor can continue to try and reacquire a lost target using a higher detection probability than applies to initial acquisition. This period is given as a positive real number with units chosen from **(SEC)**, **(MIN)** or **(HR)**. This entry is optional and if omitted the reciprocal of the **ACQ-SENSING-RATE** is used.

Optional

AZIMUTH-SLEW-LIMITS

Block Format

This data item provides a way to represent the left and right physical slewing limits of an antenna, if this data item is omitted the sensor can slew to point in any direction. The azimuth slew limits are relative to the heading of the location which includes the sensor receiver. The heading for a moving location is aligned with its velocity vector and the heading for a stationary location can be assigned using **HDG:** in the **SDB LOC:** sentences, or changed dynamically using **WITH-TGT-CUING** or **WITH-SDB-CUING** phrases in the resource allocation. There are two required inputs **LEFT-AZ:** and

The Type Data Base

Sensor Receiver Capabilities

RIGHT-AZ: each one being followed by a positive real number for an azimuth angle from the range $[0 \rightarrow \pi]$ or $[0.0 \rightarrow 180.0]$ with units of either (RADIANS) or (DEG).

EFFECTIVE-EARTH-RADIUSOne-line Format

Allows the curvature of the Earth and the bending of energy beams due to refraction to be taken into account. If this data item is omitted calculations use a flat Earth. The entries are the <radius>, a positive real number, with <units> as (M), (KM), (FT) or (MILES).

EFF-BURST-CM-PROBOne-line Format

This stands for 'Effective Burst Countermeasures Probability' and is normally used against tracking sensors. It specifies the probability that any implicitly modelled countermeasures named in the associated **IMPLICIT-CM-INTERACT** entry can cancel an otherwise successful sensing chance. The probability is a positive real number from the range $(0.0 \rightarrow 1.0]$ followed by the entry (NO-UNITS).

ELEV-SLEW-LIMITSBlock Format

This data item defines the elevation limits within which the antenna can slew to point at a target. It is only relevant for sensors defined as **FREQ-DRIVEN** in their **SNR-CHARACTERISTICS**. **PHYSICAL-SCAN** sensors cannot slew in elevation at all. When omitted **FREQ-DRIVEN** sensors have no limits placed on their ability to slew in elevation. There are two entries:

MAX-EL is the maximum elevation angle

MIN-EL is the minimum elevation angle

Both entries are followed by a real number for an elevation angle with units chosen from either (RADIANS) or (DEG).

HITS-TO-ESTABLISH-TRACK**HITS-TO-ESTABLISH-TRACK- (DRY)**One-line Format**HITS-TO-ESTABLISH-TRACK- (MB)**

Defines the number of successful detections, or hits, required to positively identify a target. This data item may be used in conjunction with **SCANS-IN-ESTABLISHING-TRACK- (DRY)** to define the maximum number of sensing chances that the requisite number of hits must be achieved within. The entry is a positive integer with (NO-UNITS), if omitted only one hit is required.

HITS-TO-ESTABLISH-TRACK- (JAM)One-line Format

Defines the number of successful detections, or hits, required to positively identify a target when jamming is present. This data item may be used in conjunction with **SCANS-IN-ESTABLISHING-TRACK- (JAM)** to define the maximum number of sensing chances that the requisite number of hits must be achieved within. The entry is a positive integer with (NO-UNITS), if omitted the value of **HITS-TO-ESTABLISH-TRACK** is used or if that is also missing only one hit is required.

IMPLICIT-CM-INTERACTName Format

This entry names the implicit disruptors which can influence the sensor receiver. This entry is used in conjunction with the **EFF-BURST-CM-PROB** command. The items named are chosen from the list of disruptors in the UAN.

MAX-PARALLEL-TRACKSOne-line Format

Defines the maximum number of engagements that a tracking sensor receiver can be used for at once. It is a required entry for tracking sensor receivers. The input is this limit specified as a positive integer followed by the entry **(NO-UNITS)**.

POLARIZATION-EFFECTSBlock Format

This data item provides a set of factors which either attenuate or magnify the power received from a jammer to take into account the receiver's capabilities to detect polarized signals. It is an optional entry for sensor receivers that can be affected by a disruptor system. The input has the following required entries:

HORIZONTAL

VERTICAL

LEFT-CIRCULAR

RIGHT-CIRCULAR

each being followed by a non-negative real multiplier with units specified as **(NO-UNITS)**. Each factor ranges between zero and one for attenuation and greater than one for magnification. If disruptors are present in the scenario and this data item is absent then the default multiplicative factor is unity. These characteristics to have a meaning the **DISRUPTOR-CHARACTERISTICS** must allow the relevant jammers to transmit polarized signals.

SCANS-IN-ESTABLISHING-TRACK-(DRY)One-line Format

Defines the maximum number of scans, i.e. sensing chances, that are allowed within which the required number of hits, i.e. successful detections of a target, must be achieved in order to perceive the target. This quantity is given as a positive integer with **(NO-UNITS)**. The required number of hits is defined with **HITS-TO-ESTABLISH-TRACK**. If omitted no limit is placed on the number of scans.

SCANS-IN-ESTABLISHING-TRACK-(JAM)One-line Format

Defines the maximum number of scans, i.e. sensing chances, that are allowed within which the required number of hits, i.e. successful detections of a target, must be achieved in order to perceive the target when jamming is present. This quantity is given as a positive integer with **(NO-UNITS)**. The required number of hits is defined with **HITS-TO-ESTABLISH-TRACK-(JAM)**. If omitted the value of **SCANS-IN-ESTABLISHING-TRACK** is used or if that is also absent no limit is placed on the number of scans.

The Type Data Base

Sensor Receiver Capabilities

SEEKER-ERROR-DATABlock Format

Describes errors in perceived target locations. This data item should only be used when **FREQ-DRIVEN** is specified in **SNR-CHARACTERISTICS** and if it is omitted there is no error in a sensed target position. There are eight entries, each being either a mean or standard deviation of normal distribution of errors. If the true azimuth Φ of a target is related to the azimuth of the boresight, Φ_B and the azimuthal deviation of the target $\Delta\Phi$ by:

$$\Phi = \Phi_B + \Delta\Phi$$

then the measured azimuth $\tilde{\Phi}$ will be given by

$$\tilde{\Phi} = \varepsilon_B + \Phi_B + \varepsilon_S \Delta\Phi$$

where the azimuthal errors are the boresight error ε_B , measured in units of (DEG) or (RADIANs), and the scale error ε_S measured in (NO-UNITS) respectively. These errors are modelled in Suppressor as being drawn from a normal distribution whose mean and standard deviation are specified by **AZ-BORESGT-ERROR-MEAN**, **AZ-BORESGT-ERROR-DEV**, **AZ-SCALE-FACTOR-MEAN** and **AZ-SCALE-FACTOR-DEV** respectively.

A similar relationship holds for errors in elevation and these are specified with the help of **EL-BORESGT-ERROR-MEAN**, **EL-BORESGT-ERROR-DEV**, **EL-SCALE-FACTOR-MEAN** and **EL-SCALE-FACTOR-DEV** respectively

SNR-ANGULAR-LIMITSOption Format

Defines the limits to the field of view of a sensor receiver in both azimuth and elevation. If this data item is omitted the sensor has an unlimited field of view. A sensor cannot detect a target outside of its field of view regardless of the setting of any antenna pattern that may be present. Note, however, that whether a target is inside the field of view depends not only on the defined angular limits but also on what direction the sensor is pointing at the time of the sensing chance. There are two entries with options depending upon whether the angular limits are symmetric or asymmetric. The choices are summarized in the table below:

Limits	Definition	Entry
AZ-LIMIT	Horizontally symmetric limits	[0.0→180.0] or [0→ π]
LOWER-AZ-LIMIT UPPER-AZ-LIMIT	Horizontally asymmetric limits	[-180.0→540.0] or [$-\pi \rightarrow 3\pi$]
EL-LIMIT	Vertically symmetric limits	[0.0→90.0] or [0.0→ $\pi/2$]
LOWER-EL-LIMIT UPPER-EL-LIMIT	Vertically asymmetric limits	[-90.0→90.0] or [$-\pi/2 \rightarrow \pi/2$]

The entries are all real numbers with units of either (DEG) or (RADIANS).

SNR-DOPPLER-LIMITSBlock Format

Defines the maximum and minimum limits of radial speed at which a sensor is able to detect a target:

MIN-DOPPLER The minimum radial speed at which a target can be seen

MAX-DOPPLER The maximum radial speed at which a target can be seen

This entry can be specified for any sensor receiver but is likely to be most useful for radar receivers. Either one or both of these may be entered as positive real numbers with units as (M/SEC), (KM/HR), (FT/SEC) or (MPH).

SNR-TIME-DELAYSBlock Format

Allows the definition of three types of time delays for sensor receivers by setting one or more of the following options to times given as non-negative real numbers with units of either (SEC), (MIN) or (HR).

START-LOCKON-DELAY is the time delay between the decision to use a tracking sensor receiver and its first scheduled sensing chance. It has a default of zero.

MAX-COAST-TIME has two different interpretations, the first is the length of time a tracker sensor receiver can remain in a coast mode after losing a target without causing any ordnance which is enroute to the target to abort. The default value for this item is zero.

A second meaning is used with all sensor receivers, not just tracking sensors. When set it implies that any recently lost target can be reacquired with just one successful detection, or 'hit', for a period with this duration. This allows the minimum value of hits normally required by the **HITS-TO-ESTABLISH-TRACK** entry can be ignored. The default value for this meaning is **TIME-BEFORE-DROP**.

POST-LOCKON-S/N-DELAY defines how long the normal sensing threshold must be used by a tracking sensor receiver before the lower **POST-LOCKON-THRESHOLD** defined in the **DETECTION-SENSITIVITIES** section can be used.

SNR-TRACKING-PROBABILITIESBlock Format

This is a required entry for tracking sensor receivers. It gives the probabilities of a tracking sensor being able to achieve an initial lockon of a target and of it being able to maintain this lockon.

INITIAL-LOCK-PROB for lockon attempts. This applies once all initial criteria for a detection have been met and gives the probability that a successful lockon will be achieved with the current detection.

CONTINUE-TRACK-PROB for maintaining lockon. This gives the probability that a lockon will successfully continue with the current detection and not be lost. If lockon is lost the sensor will go to coast mode and try to re-establish

The Type Data Base**Sensor Receiver Capabilities**

lockon for a time specified by the **MAX-COAST-TIME** entry in the **SNR-TIME-DELAYS** data item.

Each option is followed by two entries, the probability given as real number lying in the range [0.0→1.0] followed by the keyword (**NO-UNITS**).

TRANSMISSION-LOSSDimensional Format

Describes any type of transmission loss of signal strength due to its transmission through an atmosphere. The input has four lists with **DIMENSION** statements labelled with the entries below:

FREQ The frequencies of the transmitted signals, with at least two frequency values being required. These values are positive real numbers with units chosen from **(HZ)**, **(KHZ)**, **(MHZ)** or **(GHZ)**.

ALT-XMIT Specifies altitude intervals for the transmitter using real number with units of **(M)**, **(KM)**, **(FT)**, **(MILES)** or **(ANGELS)**.

ALT-RCVR Specifies altitude intervals for the receiver using real number with units of **(M)**, **(KM)**, **(FT)**, **(MILES)** or **(ANGELS)**.

2D-DIST Denotes the intervals of projected surface distance between transmitter and receiver given as a non-negative real number with units selected from **(M)**, **(KM)**, **(FT)** or **(MILES)**.

GAIN This occurs once for each distance interval and specifies the gain achieved by the signal in travelling from the transmitter to the receiver as a real number with units of **(DB)**. Positive real numbers are used to represent gains and negative real numbers losses, in practice losses would be recorded for realistic models.

If this data item is absent then the default gain value is zero. Note that the transmitter and receiver are treated symmetrically in this table, so entries should also be symmetric. That is to say the losses between a transmitter at an altitude of 1 km and a receiver at ground level should be the same as the losses between a receiver at 1 km and a transmitter at ground level if they are the same distance apart.

VERTICAL-OFFSETOne-line Format

Defines the vertical offset of the antenna in relation to the altitude of the element carrying the antenna. It is recommended that this data item is included especially for antenna situated at or near ground level. The input has the entries of antenna height, a real number, and units of either **(M)**, **(KM)**, **(FT)** or **(MILES)**. The default value is that the antenna is not offset from the element carrying it.

The Type Data Base

Radar Sensor Receiver Capabilities

RADAR

Radar receivers are used in concert with sensor transmitters to detect target elements through their reflected radio frequency energy. They are usually the most important and complex sensor receivers in a Suppressor scenario. The commands available to define the capabilities of radar receivers in addition to those defined previously for all sensor receivers are as follows:

Required

DETECTION-SENSITIVITIES

Optional:

ANTGR-PATTERN

CLUTTER-TABLE

COSECANT-PATTERN

LAMBDA-PATTERN

MTI-ATTENUATION

ONE-M2-DETECT-RNG

POLARIZATION-EFFECTS

PEAK-GAIN

RCVR-BANDWIDTH SCANS-IN-ESTABLISHING-TRACK-(DRY)

SCANS-IN-ESTABLISHING-TRACK-(JAM) SINE-PATTERN

SNR-JMR-INTERACTIONS

Required

DETECTION-SENSITIVITIES

Block Format

Defines the capability of the radar receivers to detect targets in different circumstances. All the following entries are given as positive real numbers with units of (DB) .

Entry	Definition
SENSING-THRESHOLD	Minimum signal to noise ratio needed for detection of each sensor chance.
POST-LOCKON-THRESHOLD	The minimum signal to noise ratio needed for detection by a sensor in tracking mode
RECEIVER-NOISE	The internal receiver noise measured as a ratio where a receiver with internal noise of 1 W would have a noise ratio of 0 dB.
INTERNAL-LOSSES	The signal loss which occurs within the receiver. Given as the receiver's efficiency so that negative values are the norm.
OPERATING-LOSSES	The signal loss which occurs due to operation of the radar system. These may include such items as the eclipsing of the received signal by the radar's transmissions etc. These losses therefore do not weaken the influence of jamming.
S/J-NOISE-THRESHOLD	The signal to noise ratio which replaces SENSING-THRESHOLD when noise jamming is present
S/J-PULSE-THRESHOLD	The signal to noise ratio which replaces SENSING-THRESHOLD when pulse jamming is present
J/N-NOISE-OPERATOR-THRESHOLD	The jamming signal to noise ratio which allows the radar operator that the radar is being noise jammed. If omitted this has a value of 380.0 dB.
J/N-PULSE-OPERATOR-THRESHOLD	The jamming signal to noise ratio which allows the radar operator that the radar is being pulse jammed. If omitted this has a value of 380.0 dB.

Optional

ANTENNA-PATTERN

Dimensional Format

Energy is not received or transmitted uniformly in all directions by a radio antenna, instead the antenna will have a different efficiency in different directions. This data item allows representation of different types of antenna patterns. The format is tabular with two **DIMENSION** statements labelled by **AZ** and **EL** describing the antenna's azimuthal and elevation dependence respectively. The effectiveness of the antenna is expressed by its **GAIN** in units of (DB) which gives the ratio between the energy that is focused in that angular range by the antenna and the amount of energy that would be focused in that region by a perfectly uniform antenna pattern. So if the antenna channels 100 times as much energy in a certain direction than a uniform antenna would then its gain would be 20 dB.

The Type Data Base

Radar Sensor Receiver Capabilities

Label	Allowed Units	Form of Entry
AZ	(DEG) or (RADIANS)	Real number in the range $[0.0^\circ \rightarrow 180.0^\circ]$ or $[0.0 \rightarrow \pi]$
EL	(DEG) or (RADIANS)	Real number in the range $[-90.0^\circ \rightarrow 90.0^\circ]$ or $[-\pi/2 \rightarrow \pi/2]$
GAIN	(DB)	Real number

There is an assumed left-right symmetry in azimuth, but no up-down symmetry in elevation.

ANTGR-PATTERNBlock Format

An alternative to **ANTENNA-PATTERN** for radar receivers. It defines the parameters which specify an antenna pattern using built in tables. There are four required inputs:

PATTERN-ID identifies the antenna pattern number. This is entered as a real number with **(NO-UNITS)**. Since the pattern numbers are contained in an unavailable US document this command is not really useful for non-US users.

GAIN-CORRECTION is an amplitude adjustment value entered as a real number with units of **(DB)**. This adjustment is added to each gain value.

MIN-GAIN is the minimum gain value for this antenna also entered as a real number with units of **(DB)**.

EL-ROTATION is used to rotate the pattern in elevation, either up with a positive real number or down with a negative real number. These have units of either **(DEG)** or **(RADIANS)**.

CLUTTER-TABLEDimensional Format

This data item defines a table of clutter values which can be added to the noise term for radar receivers. Clutter values vary with change in altitude and range of the target and are tabulated with two **DIMENSION** statements labelled with the keywords **ALT** and **RNG** respectively. Each pair of altitude and range intervals have a corresponding **CLUTTER-POWER** defined measured in units of **(DB)**. Since any clutter power c should increase the noise C arriving at the receiver the total noise N is given by $N = C(1 + c)$. The entries are summarized below:

Label	Allowed Units	Description
ALT	(M) (FT) (KM) (MILES) or (NM)	Altitude above ground level given as a real number.
RNG	(M) (FT) (KM) (MILES) or (NM)	Range from receiver positive real number.
CLUTTER-POWER	(DB)	Clutter power given as a real number.

COSECANT-PATTERN

Block Format

This entry is an alternative to the use of an **ANTENNA-PATTERN**. It allows an antenna having a cosecant squared pattern to be defined using just six entries. Cosecant squared antennae are designed to maintain a constant return from a target which is approaching at a constant altitude. The maximum and minimum gains of the antenna are specified in units of (DB) using the items:

PEAK-GAIN is the maximum gain of the antenna pattern

MIN-GAIN is the minimum gain of the antenna pattern

These are followed by the pattern's azimuthal beamwidth:

AZ-BEAMWIDTH is the beamwidth of the antenna pattern in the azimuthal plane

In elevation three angles must be specified to fully describe the antenna's gain:

MIN-EL-FOR-PEAK-GAIN is the minimum elevation at which the gain of the antenna pattern has the value **PEAK-GAIN**. At elevations less than this value the gain of the antenna is specified by the **MIN-GAIN**.

PEAK/CSC2-BOUNDARY-EL is the elevation angle which divides the part of the antenna pattern which has **PEAK-GAIN** from the cosecant squared portion of the pattern. This is the lower boundary of the cosecant squared portion of the antenna pattern.

MAX-EL-FOR-CSC2 is the upper limit of the cosecant squared portion of the antenna pattern. At elevation angles greater than this angle the antenna's gain is again specified with **MIN-GAIN**.

The above angles should be specified as positive real numbers with units of (DEG) or (RADIANS). If **COSECANT-PATTERN** is used in addition to either **ANTENNA-PATTERN** or **ANTGR-PATTERN** then the **COSECANT-PATTERN** data will be used.

LAMBDA-PATTERN

Block Format

This entry is an alternative to the use of an **ANTENNA-PATTERN**. It allows an antenna having a 'sine pattern', $(\sin x/x)^2$, to be defined using just three entries. It is appropriate for circular antennae with uniform illumination. The first two entries are real numbers specifying the gains of the pattern in (DB):

PEAK-GAIN is the maximum gain of the antenna pattern.

MIN-GAIN is the minimum gain of the antenna pattern.

The final entry is the beamwidth of the antenna specified as a positive real number with units of (DEG) or (RADIANS).

BEAMWIDTH is the beamwidth of the antenna pattern. i.e. the angular width of the pattern at its half power (-3dB) points.

If **LAMBDA-PATTERN** is given in addition to either **ANTENNA-PATTERN** or **ANTGR-PATTERN** then the **LAMBDA-PATTERN** entry will be used to define the antenna pattern.

The Type Data Base

Radar Sensor Receiver Capabilities

MTI-ATTENUATIONDimensional Format

MTI stands for moving target indicator and this entry is used to define the amount of attenuation of an input signal based on the signal's frequency. This frequency is a beat arising from the transmission frequency of the signal, the pulse repetition frequency of the transmitted frequency and the radial velocity of the target. As such MTI capability is used in radars which can discriminate between moving and stationary targets. If this data item is used then **PULSE-REPETITION-FREQUENCY** must be set for the linked sensor transmitter. The command's input is in a tabular format with one **DIMENSION** statement labelled with the keyword **FREQ** and with attenuation factors following the keyword **LOSS** for each frequency interval. These entries are summarized below:

FREQ which contains a set of frequencies as non-negative real numbers from the range [0.0→radar pulse repetition frequency] with units in (HZ), (KHZ), (MHZ) or (GHZ).

LOSS which is an attenuation factor associated with each frequency interval. It is a non-negative real number from the range [0.0→1.0] followed by the entry (NO-UNITS)

ONE-M2-DETECT-RNGOne-line Format

This entry can be used to calibrate the range at which a target with a radar cross section of one square metre can be detected. The range is entered as a positive real number with units of either (M), (KM), (FT) or (MILES). Radar calibration can be modelled either through this data item or explicitly with the help of the **RECEIVER-NOISE** entry in the **DETECTION-SENSITIVITIES** data item. When both entries are present the **RECEIVER-NOISE** entry will be automatically changed to agree with the value of **ONE-M2-DETECT-RNG**.

PEAK-GAINOne-line Format

This entry defines the maximum gain of the antenna used by the radar receiver. It is a required entry when used in conjunction with **ANTENNA-PATTERN** and **ONE-M2-DETECT-RNG** for a radar receiver, since it is used to calibrate the radar's range. It may be omitted when the antenna pattern is defined with **COSECANT-PATTERN**, **LAMBDA-PATTERN** or **SINE-PATTERN** since these entries already incorporate a **PEAK-GAIN** item

RCVR-BANDWIDTHOne-line Format

Required for sensor receivers which can be explicitly jammed. It gives the receiver's bandwidth as a positive real number with units of (HZ), (KHZ), (MHZ) or (GHZ). It allows the spectral power density of the incoming jamming signal to be computed and its effectiveness in jamming the signal evaluated. defines the frequency response of a receiver.

SINE-PATTERNBlock Format

This entry is an alternative to the use of an **ANTENNA-PATTERN**. It allows an antenna having a 'sine pattern', $(\sin x/x)^2$, to be defined using just five entries. It is appropriate for rectangular or elliptical antennae with uniform illumination. The first two entries specify the gains of the pattern in (DB):

PEAK-GAIN is the maximum gain of the antenna pattern,

MIN-GAIN is the minimum gain of the antenna pattern,

The next two entries specify the pattern's beamwidths as positive real numbers with units of either (DEG) or (RADIANS):

AZ-BEAMWIDTH is the beamwidth of the antenna pattern in the azimuth plane,

EL-BEAMWIDTH is the beamwidth of the antenna pattern in the elevation plane,

With a final entry being used to alter the direction of the antenna's boresight in elevation through an angle measured in either (DEG) or (RADIANS):

EL-BORESIGHT-ANGLE is used to incline the boresight of the pattern either up through a positive angle or down through a negative angle given as a real number. The input is a real number with units as either (DEG) or (RADIANS).

If **SINE-PATTERN** is given in addition to either **ANTENNA-PATTERN** or **ANTGR-PATTERN** then the **SINE-PATTERN** entry will be used to define the antenna pattern.

SNR-JMR-INTERACTIONSName Format

Defines which jammers, i.e. explicit disruptors, are effective against this radar receiver. The entries should be the name of all jammer types which can interact with the sensor receiver taken from the list of disruptors in the UAN.

The Type Data Base

Radar Warning Sensor Receiver Capabilities

RADAR WARNING RECEIVER

Radar warning receivers detect the radio frequency emissions of other player's transmitters. Since they do not sense a target element directly they cannot be used in isolation to lethally engage targets. The commands available to define the capabilities of radar warning receivers in addition to those defined previously for all sensor receivers are as follows:

Required**DETECTION-SENSITIVITIES**Optional:**ANTENNA-PATTERN****ANTGR-PATTERN****COSECANT-PATTERN****HITS-TO-ESTABLISH-TRACK-(BL)****LAMBDA-PATTERN****RCVR-FREQ-LIMITS****RWR-DETECTION-CRITERIA****SINE-PATTEN****SNR-JMR-INTERACTIONS**Required**DETECTION-SENSITIVITIES**Block Format

Defines the capability of radar warning receivers to detect targets in different circumstances. All the following entries are given as positive real numbers with units of (DB).

Entry	Definition
SENSING-THRESHOLD	Minimum signal to noise ratio needed for detection of each sensor chance.
POST-LOCKON-THRESHOLD	The minimum signal to noise ratio needed for detection by a sensor in tracking mode
RECEIVER-NOISE¹	The internal receiver noise measured as a ratio where a receiver with internal noise of 1 W would have a noise ratio of 0 dB.
INTERNAL-LOSSES	The signal loss which occurs within the receiver. Given as the receiver's efficiency so that negative values are the norm.

Optional**ANTENNA-PATTERN**Dimensional Format

Energy is not received or transmitted uniformly in all directions by a radio antenna, instead the antenna will have a different efficiency in different directions. This data item allows representation of different types of antenna patterns. The format is tabular with two **DIMENSION** statements labelled by **AZ** and **EL** describing the antenna's azimuthal and elevation dependence respectively. The effectiveness of the antenna is expressed by its **GAIN** in units of (DB) which gives the ratio between the energy that is focused in that angular range by the antenna and the amount of energy that would be

focused in that region by a perfectly uniform antenna pattern. So if the antenna channels 100 times as much energy in a certain direction than a uniform antenna would then its gain would be 20 dB.

Label	Allowed Units	Form of Entry
AZ	(DEG) or (RADIANS)	Real number in the range $[0.0^\circ \rightarrow 180.0^\circ]$ or $[0.0 \rightarrow \pi]$
EL	(DEG) or (RADIANS)	Real number in the range $[-90.0^\circ \rightarrow 90.0^\circ]$ or $[-\pi/2 \rightarrow \pi/2]$
GAIN	(DB)	Real number

There is an assumed left-right symmetry in azimuth, but no up-down symmetry in elevation.

ANTGR-PATTERN

Block Format

An alternative to **ANTENNA-PATTERN** for radar warning receivers. It defines the parameters which specify an antenna pattern using built in tables. There are four required inputs:

PATTERN-ID identifies the antenna pattern number. This is entered as a real number with **(NO-UNITS)**. Since the pattern numbers are contained in an unavailable US document this command is not really useful for non-US users.

GAIN-CORRECTION is an amplitude adjustment value entered as a real number with units of **(DB)**. This adjustment is added to each gain value.

MIN-GAIN is the minimum gain value for this antenna also entered as a real number with units of **(DB)**.

EL-ROTATION is used to rotate the pattern in elevation, either up with a positive real number or down with a negative real number. These have units of either **(DEG)** or **(RADIANS)**.

COSECANT-PATTERN

Block Format

This entry is an alternative to the use of an **ANTENNA-PATTERN**. It allows an antenna having a cosecant squared pattern to be defined using just six entries. Cosecant squared antennae are designed to maintain a constant return from a target which is approaching at a constant altitude. The maximum and minimum gains of the antenna are specified in units of **(DB)** using the items:

PEAK-GAIN is the maximum gain of the antenna pattern

MIN-GAIN is the minimum gain of the antenna pattern

These are followed by the pattern's azimuthal beamwidth:

AZ-BEAMWIDTH is the beamwidth of the antenna pattern in the azimuthal plane

In elevation three angles must be specified to fully describe the antenna's gain:

The Type Data Base

Radar Warning Sensor Receiver Capabilities

MIN-EL-FOR-PEAK-GAIN is the minimum elevation at which the gain of the antenna pattern has the value **PEAK-GAIN**. At elevations less than this value the gain of the antenna is specified by the **MIN-GAIN**.

PEAK/CSC2-BOUNDARY-EL is the elevation angle which divides the part of the antenna pattern which has **PEAK-GAIN** from the cosecant squared portion of the pattern. This is the lower boundary of the cosecant squared portion of the antenna pattern.

MAX-EL-FOR-CSC2 is the upper limit of the cosecant squared portion of the antenna pattern. At elevation angles greater than this angle the antenna's gain is again specified with **MIN-GAIN**.

The above angles should be specified as positive real numbers with units of (DEG) or (RADIAN). If **COSECANT-PATTERN** is used in addition to either **ANTENNA-PATTERN** or **ANTGR-PATTERN** then the **COSECANT-PATTERN** data will be used.

HITS-TO-ESTABLISH-TRACK-(BL)One-line Format

Defines the number of successful detections, or hits, required to positively identify a target when using a warning receiver to detect backlobe emissions from a transmitter. This data item may be used in conjunction with **SCANS-IN-ESTABLISHING-TRACK** to define the maximum number of sensing chances that the requisite number of hits must be achieved within. The entry is a positive integer with (NO-UNITS), if omitted then backlobe detections are ignored. The sensing chance with the backlobe beam is scheduled independently and in addition to that of the mainbeam. This entry assumes the appropriate settings for **RWR-DETECTION-CRITERIA** have been made.

LAMBDA-PATTERNBlock Format

This entry is an alternative to the use of an **ANTENNA-PATTERN**. It allows an antenna having a 'sine pattern', $(\sin x/x)^2$, to be defined using just three entries. It is appropriate for circular antennae with uniform illumination. The first two entries are real numbers specifying the gains of the pattern in (DB):

PEAK-GAIN is the maximum gain of the antenna pattern.

MIN-GAIN is the minimum gain of the antenna pattern.

The final entry is the beamwidth of the antenna specified as a positive real number with units of (DEG) or (RADIAN).

BEAMWIDTH is the beamwidth of the antenna pattern. i.e. the angular width of the pattern at its half power (-3dB) points.

If **LAMBDA-PATTERN** is given in addition to either **ANTENNA-PATTERN** or **ANTGR-PATTERN** then the **LAMBDA-PATTERN** entry will be used to define the antenna pattern.

RCVR-FREQ-LIMITSBlock Format

Defines the upper and lower frequency limits that the warning receiver can detect:

LOWER-FREQ-LIMIT

UPPER-FREQ-LIMIT

Both are followed by the relevant frequency limit given as a positive real number with units of (HZ), (KHZ), (MHZ) or (GHZ). If this data item is omitted, the warning receiver can detect emissions at any frequency.

RWR-DETECTION-CRITERIAOne-line Format

Defines the criteria to be used by a warning receiver in detecting RF emissions. Only one entry is given which is chosen from the following options:

MAINBEAM-ONLY, the default option which indicates that the warning receiver can only detect mainbeam transmissions.

BACKLOBE-ONLY, the warning receiver can only detect backlobe transmissions.

BOTH-MAINBEAM/BACKLOBE, the warning receiver can detect both mainbeam and backlobe transmissions.

SINE-PATTERNBlock Format

This entry is an alternative to the use of an **ANTENNA-PATTERN**. It allows an antenna having a 'sine pattern', $(\sin x/x)^2$, to be defined using just five entries. It is appropriate for rectangular or elliptical antennae with uniform illumination. The first two entries specify the gains of the pattern in (DB):

PEAK-GAIN is the maximum gain of the antenna pattern,

MIN-GAIN is the maximum gain of the antenna pattern,

The next two entries specify the pattern's beamwidths as positive real numbers with units of either (DEG) or (RADIANS):

AZ-BEAMWIDTH is the beamwidth of the antenna pattern in the azimuth plane,

EL-BEAMWIDTH is the beamwidth of the antenna pattern in the elevation plane,

With a final entry being used to alter the direction of the antenna's boresight in elevation through an angle measured in either (DEG) or (RADIANS):

EL-BORESIGHT-ANGLE is used to incline the boresight of the pattern either up through a positive angle or down through a negative angle given as a real number. The input is a real number with units as either (DEG) or (RADIANS).

If **SINE-PATTERN** is given in addition to either **ANTENNA-PATTERN** or **ANTGR-PATTERN** then the **SINE-PATTERN** entry will be used to define the antenna pattern.

SNR-JMR-INTERACTIONSName Format

Defines which jammers, i.e. explicit disruptors, are effective against this radar warning receiver. The entries should be the name of all jammer types which can interact with the sensor receiver taken from the list of disruptors in the UAN.

The Type Data Base

Optical Sensor Receiver Capabilities

OPTICAL SENSOR RECEIVERS

Optical sensing is modelled in Suppressor by detecting a target's contrast with the background. The larger the target and the greater the contrast the easier the target is to see. The relationship used by Suppressor to compute the perceived contrast C is:

$$C = C_i \frac{A_i B_b}{A_i B_b + B_p}$$

Here the path radiance is B_p , the background radiance is B_b , and the target's inherent contrast is C_i , with the transmittance through the atmosphere being A_i ; to determine the total contrast C . Increasing the ratio of path radiance to the product of background radiance and transmittance diminishes the target's contrast. The target's size and inherent contrast were set with the susceptibility entries **OPT-CS** and **INHERENT-CONTRAST**. The background and path radiances are set with **BACKGROUND-RADIANCE** and **PATH-RADIANCE** respectively whilst the atmospheric transmittance is set with **TRANSMISSION-LOSSES**.

The following items are available to define optical sensor receivers in addition to those available for all sensor receivers listed previously:

Required**DETECTION-SENSITIVITIES****PATH-RADIANCE****SEARCH-GLIMPSE-PROB****BACKGROUND-RADIANCE****REACQ-GLIMPSE-PROB****TRACK-GLIMPSE-PROB**Optional:**XMIT-FREQ**Required**DETECTION-SENSITIVITIES**Block Format

Defines the capability of optical sensor receivers to detect targets in different circumstances. All the following entries are cumulative probabilities of detection given as real numbers lying between zero and one with **(NO-UNITS)**.

Entry	Definition
SENSING-THRESHOLD	Minimum cumulative probability that needs to be reached for the detection of the target.
POST-LOCKON-THRESHOLD	Minimum cumulative probability of detection that must be maintained to retain lockon of a target

The detection of a target with an optical sensor depends on the current cumulative probability of many individual glimpses. If each glimpse i has a probability of detection P_i then the cumulative probability that the target has been detected after N glimpses is:

$$P_N = 1 - \prod_{i=1}^N (1 - P_i).$$

Once P_N exceeds the relevant sensing threshold the target is considered to have been successfully detected

BACKGROUND-RADIANCE

Dimensional Format

This data item defines the background radiance of a target for an optical sensor receiver as a function of target altitude, receiver altitude and distance. It is recommended that it be included for every optical sensor. The entry is in tabular format with three **DIMENSION** statements labelled with **ALT-TGT**, **ALT-RCVR** and **2D-DIST**. These describe the height of the target and receiver above mean sea level and the projected ground distance between them respectively. All the measures may use units of **(M)**, **(FT)**, **(KM)**, **(MILES)** or **(NM)** and are followed by one or more intervals bracketing possible altitudes and distances.

Each triplet of altitude and distance intervals has a corresponding **RADIANCE** defined in units of **(W/SR/M2)**. Larger values of the background radiance increase the target's contrast. If omitted then the background radiance is assumed to be zero which makes the target's contrast zero and so invisible for most glimpse probabilities which are zero for zero contrast. As such this entry is recommended.

The table has the following form:

```

BACKGROUND-RADIANCE
  DIMENSION 1  ALT-TGT  <units>
    <altitude> <altitude> ...
  DIMENSION 2  ALT-RCVR <units>
    <altitude> <altitude> ...
  DIMENSION 3  2D-DIST <units>
    <distance> <distance> ...
    RADIANCE (W/SR/M2)
      <radiance> ...
.
END PATH-RADIANCE

```

PATH-RADIANCE

Dimensional Format

This data item defines the path radiance of a target for an optical sensor receiver as a function of target altitude, receiver altitude and distance. It must be specified for every optical sensor. The entry is in tabular format with three **DIMENSION** statements labelled with **ALT-TGT**, **ALT-RCVR** and **2D-DIST**. These describe the height of the target and receiver above mean sea level and the projected ground distance between them respectively. All the measures may use units of **(M)**, **(FT)**, **(KM)**, **(MILES)** or **(NM)** and are followed by one or more intervals bracketing possible altitudes and distances.

The Type Data Base

Optical Sensor Receiver Capabilities

Each triplet of altitude and distance intervals has a corresponding **RADIANCE** defined in units of (W/SR/M2). Smaller values of the path radiance increase the target's contrast. The path radiance has no default value if omitted and so must always be included.

The table has the following form:

```

PATH-RADIANCE
  DIMENSION 1  ALT-TGT  <units>
    <altitude> <altitude> ...
  DIMENSION 2  ALT-RCVR <units>
    <altitude> <altitude> ...
  DIMENSION 3  2D-DIST <units>
    <distance> <distance> ...
  RADIANCE (W/SR/M2)
    <radiance> ...
.
END PATH-RADIANCE

```

REACQ-GLIMPSE-PROBDimensional Format

This defines the single glimpse probabilities of re-acquiring a target that has being lost. This detection probability can be used for a limited time after the target was lost. This time is given by the **REACQUISITION-TIME** option, or if this was not given, the reciprocal of the **ACQ-SENSING-RATE** entry, both of these being given in the sensor's **SENSING-MODE-RATES** definition.

The command's format is tabular with two **DIMENSION** statements labelled by **SIZE** and **CONTRAST** respectively. These two entries are followed by lists of one or more real valued intervals defining the possible target sizes and contrasts with units of (SR) and (NO-UNITS) respectively.

Each pair of size and contrast intervals has a corresponding reacquisition probability **DETECT-PROB** lying between zero and one with (NO-UNITS).

SEARCH-GLIMPSE-PROBDimensional Format

This defines the single glimpse probabilities of initially acquiring a target. The command's format is tabular with two **DIMENSION** statements labelled by **SIZE** and **CONTRAST** respectively. These two entries are followed by lists of one or more real valued intervals defining the possible target sizes and contrasts with units of (SR) and (NO-UNITS) respectively.

Each pair of size and contrast intervals has a corresponding reacquisition probability **DETECT-PROB** lying between zero and one with (NO-UNITS).

TRACK-GLIMPSE-PROBDimensional Format

This defines the single glimpse probabilities of successfully tracking a target. The command's format is tabular with two **DIMENSION** statements labelled by **SIZE** and **CONTRAST** respectively. These two entries are followed by lists of one or more real valued intervals defining the possible target sizes and contrasts with units of **(SR)** and **(NO-UNITS)** respectively.

Each pair of size and contrast intervals has a corresponding reacquisition probability **DETECT-PROB** lying between zero and one with **(NO-UNITS)**.

Optional**XMIT-FREQ**One-line Format

Specifies the frequency band used by the optical sensor. It is the default operating frequency if no frequencies are defined in the SDB using the **FREQ:** statement. The frequency is given as a positive real number with units of **(HZ)**, **(KHZ)**, **(MHZ)** or **(GHZ)**. Its use is in determining the atmospheric transmittance for the optical sensor receiver with the help of the **TRANSMISSION LOSS** table.

The Type Data Base

Infrared Sensor Receiver Capabilities

INFRARED SENSOR RECEIVERS

Infrared sensing is modelled by Suppressor by computing the infrared radiation given off by the target, known as the infrared cross-section σ_{IR} of the target. The relationship describing this is:

$$\sigma_{IR} = I_{IR} + A \left(\frac{\alpha S}{4\pi} - B \right).$$

In this relationship I_{IR} is the intrinsic infrared intensity of the target, specified by the **IR-INTENSITY** entry and A is the target's projected area specified in the target's **OPT-CS** entry. Both of these entries are in the target's susceptibility block. The remaining term describes the relative brightness of the target to its background. The background radiance is B set by the **BACKGROUND-RADIANCE** entry of the infrared receiver. The target's radiance is $\alpha S / 4\pi$ where α is the target's reflectivity specified by the target's **TGT-REFLECTIVITY** table. Finally S is the solar irradiance defined by the **SOLAR-IRRADIANCE** table.

The following items are available to define infrared sensor receivers in addition to those available for all sensor receivers listed previously:

Required

DETECTION-SENSITIVITIES
SOLAR-IRRADIANCE

PIXEL-FIELD-OF-VIEW

Optional

BACKGROUND-RADIANCE

FREQUENCY-BAND

Required**DETECTION-SENSITIVITIES**Block Format

Defines the capability of infrared receivers to detect targets in different circumstances. All the following entries are cumulative probabilities of detection given as real numbers lying between zero and one with **(NO-UNITS)**.

Entry	Definition
SENSING-THRESHOLD	Minimum signal to noise ratio for the initial acquisition of the target.
POST-LOCKON-THRESHOLD	Minimum signal to noise ratio for the successful tracking of the target
RECEIVER-NOISE	Internal receiver noise; the 'noise equivalent irradiance' in units of (W/M2)

The signal to noise ratios are given by the ratio of the energy flux received from the target, $4\pi \sigma_{IR} / R^2$ where R is the distance to the target and its infrared cross-section is σ_{IR} and the noise equivalent irradiance defined as the receiver noise.

PIXEL-FIELD-OF-VIEWOne-line Format

Defines the maximum size of the receiver's field of view. The target's perceived angular size cannot exceed this and will be reduced to this value given as a real number with units of (SR).

SOLAR-IRRADIANCEDimensional Format

Defines the solar irradiance values as a function of target altitude. The data is input as a table with one dimension statement labelled with the keyword **ALT-TGT**. Each altitude interval has an associated irradiance specified after the keyword **IRRADIANCE**; these items being summarized below:

ALT-TGT, Intervals bracketing the target's altitude above mean sea level and given as real numbers with units of (M), (KM), (MILES), (NM), (FT) or (ANGELS)

IRRADIANCE, a positive real number with units of (W/M²) and there is one value per altitude interval.

Optional**BACKGROUND-RADIANCE**Dimensional Format

This data item defines the background radiance of a target for an infrared sensor receiver as a function of target altitude, receiver altitude and distance. The entry is in tabular format with three **DIMENSION** statements labelled with **ALT-TGT**, **ALT-RCVR** and **2D-DIST**. These describe the height of the target and receiver above mean sea level and the projected ground distance between them respectively. All the measures may use units of (M), (FT), (KM), (MILES) or (NM) and are followed by one or more intervals bracketing possible altitudes and distances.

Each triplet of altitude and distance intervals has a corresponding **RADIANCE** defined in units of (W/SR/M²). Larger values of the background radiance decrease the contrast between the target and its surroundings, the opposite of what is true for optical sensors. If omitted then the background radiance is assumed to be zero which maximizes the target's visibility.

The Type Data Base

Infrared Sensor Receiver Capabilities

The table has the following form:

```

BACKGROUND-RADIANCE
  DIMENSION 1 ALT-TGT  <units>
    <altitude> <altitude> ...
  DIMENSION 2 ALT-RCVR <units>
    <altitude> <altitude> ...
  DIMENSION 3 2D-DIST <units>
    <distance> <distance> ...
  RADIANCE (W/SR/M2)
    <radiance> ...
  ...
END PATH-RADIANCE

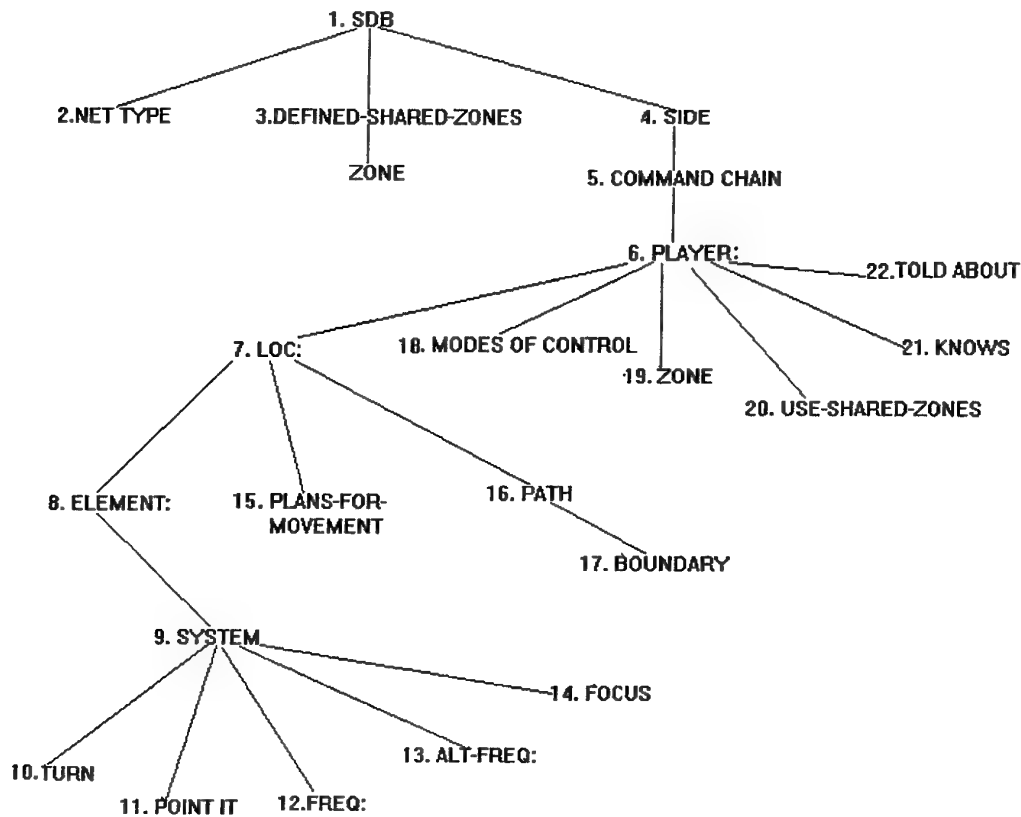
```

FREQUENCY-BANDOne-line Format

Specifies the frequency band for an infrared sensor. The only entry is a band name from the list of IR-BANDS in the UAN. It is used in conjunction with the **TGT-REFLECTIVITY** item in the target's susceptibility entries to compute the reflectivity of the target to radiation in the current frequency band.

2. The Scenario Data Base

The scenario data base (SDB) consists of many data items embedded within each other, and this hierarchical behaviour is shown in the diagram below. The data items will be considered in the order in which they would be entered into the data base.



The structure of the SDB

Many of the data items require the definition of a Location, using {Location Definition}, which is expressed in either Cartesian or spherical coordinates. The format for the coordinate input is:

{Cartesian option}

X, Y, Z: <x> <y> <xy-units> <z> <z-units> <altitude-ref>

or

{Spherical Option}

L/L,Z: <latitude> <longitude> <z> <z-units> <altitude-ref>

The Scenario Data Base

where,

<x> <y> <z> are real numbers

<latitude> <longitude> use the DDDMMSSsd format described below

<xy-units> can be (M), (KM), (FT) or (MILES)

<z-units> can be (M), (KM), (FT), (MILES) or (ANGELS)

<altitude-ref> is either AGL (above ground level) or MSL (mean sea level)

The DDDMMSSsd format is used to describe coordinates in terms of <latitude> and <longitude>.

DDD	degrees (integer)
MM	minutes (integer)
SS	seconds (integer)
s	tenths of seconds (integer)
d	N or S for latitude, E or W for longitude

The SDB begins with the keywords **EXECUTE** and **INSTRUCTIONS FOR:** as shown below:

EXECUTE INSTRUCTIONS FOR:

This is followed by the data items of the SDB, the first being the SDB command itself containing the initialization variables.

2.1. SDB

Defines the beginning and the end of the SDB, along with pertinent header initialization data. The format is:

SDB
<comment>
RANDOM-NUMBER-SEED: <seed>
RADIUS OF SCENARIO: <radius>
LOCATION RESOLUTION TIME: <resolve-time> <t-units>
START TIME: <start-time> <t-units>
STOP TIME: <stop-time> <t-units>
CHECKPOINT TIME INCREMENT: <time-incr> <t-units>
CENTER OF SCENARIO L/L: <latitude> <longitude>
<terrain-option>
[MAG-DIP-ANGLE]:
...[NET TYPE]...
[DEFINE-SHARED-ZONES]
[SIDE]...
END SCENARIO <status>

The Scenario Data Base

<comment>

A user comment line. Blanks are allowed and the comment can span more than one line of text. There is no maximum character length, but this comment must exist. It does not need to be preceded by a '\$' symbol.

RANDOM-NUMBER-SEED: <seed>

Required entry. The seed initializes the random number generator. It is a positive integer usually consisting of eight or nine digits, and it is recommended that this number is odd. This value would only be used if the seed in the MOD is set to zero.

RADIUS OF SCENARIO: <radius> <rad-units>

Required entry. The radius defines how far out from the origin of the coordinate system players in the scenario will be located and the area they could affect. The <radius> is a positive real number with <rad-units> chosen from (M), (FT), (KM) or (MILES).

LOCATION RESOLUTION TIME: <resolve-time> <t-units>

Required entry. Allows a limiting resolution time to be specified that can minimize the number of location calculations being made when a scenario has many interactions. The <resolve-time> is a non-negative real number with <t-units> selected from (SEC), (MIN) or (HR).

START TIME: <start-time> <t-units>

Required entry. Denotes when the first thing that can possibly happen in a game. <start-time> is a non-negative real number with <t-units> selected from (SEC), (MIN) or (HR).

STOP TIME: <start-time> <t-units>

Required entry. Denotes the time at which the game stops. The <stop-time> is a positive real number with <t-units> selected from (SEC), (MIN) or (HR).

CHECKPOINT TIME INCREMENT: <time-incr> <t-units>

Required entry. The time increment directs the model to write out intermediate checkpoint files at the specified intervals. Checkpoints are snapshots of model activity generated by the model during execution. The <time-incr> is a positive real number with <t-units> selected from (SEC), (MIN) or (HR). If the time increment is zero or if it is greater than the stop time, the model will not generate any checkpoint files during the scenario.

CENTER OF SCENARIO L/L: <latitude> <longitude>

Optional entry. Defines the centre of the scenario. If any scenario positions are described using latitude and longitude or if terrain is included, this entry is required; otherwise it is optional, but its use is recommended. Omitting this entry for causes the scenario to be centred at 0° E and 0° N, somewhere in the

The Scenario Data Base

Atlantic Ocean south of the Ivory Coast. <latitude> and <longitude> use a DDDMMSSsd format, where DDD are degrees , MM are minutes , SS are seconds and s is tenths of a second; finally d is N or S for latitude E or W for longitude.

<terrain-option>

Required entry only if **CENTER OF SCENARIO L/L:** is present. It informs the processor if terrain data are part of the input and how these data should be handled. There are three options:

DO-NOT-USE-TERRAIN terrain information is not being used in the scenario

TRANSLATE-TERRAIN terrain information is being used and the Binary Untranslated Terrain file (created by the EDB processing stage) is the terrain input.

USE-TRANSLATED-TERRAIN terrain is being used and the Binary Translated Terrain file (created by a previous SDB processing stage) is the terrain input.

[MAG-DIP-ANGLE:]

Optional entry. It defines a magnetic angle used in computing navigation errors and is used only if **NAV-ERROR-DATA** is set in the TDB. The syntax is:

MAG-DIP-ANGLE: <angle> <uom>,

where <uom> is either (DEG) or (RADIANS) and the <angle> is a real number.

[NET TYPE]

Required entry if communications between players will occur in the scenario. This data item will appear once for each communication net that the scenario has. See the **NET TYPE** section below for more details.

[DEFINE-SHARED ZONES]

Optional entry, but if it is present it should only occur once. It allows a zone to be only defined once although it is referred to by several player definitions. See **DEFINE-SHARED-ZONES**, **USE-SHARED-ZONES**, and **ZONE** data item descriptions below for more detail.

[SIDE]

Required for each side in the scenario, and there must be at least one occurrence of **SIDE**. See the **SIDE** data item description below for more details.

END SCENARIO: <status>

Required entry. <status> is set to either **COMPLETE** or **PARTIAL**. If there is only one SDB data item the correct entry is **COMPLETE**, if more than one SDB is being used then **PARTIAL** is the correct setting in all the SDB files except the last, which will again require **COMPLETE**.

The Scenario Data Base

2.2. NET-TYPE

This entry defines the communication nets that are being used in the scenario, and the kind of messages that are to be transmitted over each net. In addition to this the times required for each message's transmission and their priorities are also defined for each net. **NET TYPE** is required if players are going to communicate with each other and each type of net used in the scenario requires a **NET TYPE** data item.

The input for **NET TYPE** consists of two phrases: a 'Net Phrase', which appears just once, followed by one to eight 'Message Phrases'. The format for the input is:

```
NET TYPE <net-name> MODE: <transmit-mode>
      CHANGE FREQ DELAY: <delay-time> <d-units>
      MSG <message-type> TRANSMIT-TIME: <trans-time> <t-units>
      1-WAY-PRIORITY: <priority>
      .
      .
      .
```

Net Phrase

NET TYPE <net-name>

Identifies the net's type from the list of implicit or explicit nets in the UAN.

MODE: <transmit-mode>

Specifies how messages will be transmitted. There are two options for the setting of transmit mode:

INTERMITTENT Here emissions from the transmitter will occur when an explicitly modelled message is being sent. In this mode a warning receiver can only detect communication transmitters when messages are being sent.

CONTINUOUS Here a net is considered to be transmitting continuously whether or not a specific message is being sent.

CHANGE FREQ DELAY: <delay-time> <d-units>

Defines how much time is used up when changing to an alternative frequency to avoid being jammed. The <delay-time> is entered as a non-negative real number with <d-units> of (SEC), (MIN) or (HR). The delay time must appear even if there is no alternative frequency, in which case its value will be disregarded.

The Scenario Data Base

Message Phrase

There are three entries and all are required. Within a set of Message Phrases a <message-type> cannot be repeated. The first entry is **MSG** which

MSG <message-type>

This indicates what kind of message is under discussion. There are nine possibilities which are as follows:

ASGN-STAT⁴ messages dealing assignment or engagement status

CNCL-ASGN messages cancelling assignments to a subordinate

DEATH messages reporting death of a player

ENG-STAT⁴ messages reporting the engagement or assignment status

INTELL messages reporting intelligence

MOC-CHANGE messages informing of a mode of control change

MOVE-ORDER messages containing movement orders

SUB-CUING messages containing a cuing order to a subordinate

WPN-ASGN messages instructing of weapon assignments, this is used to communicate to subordinates.

TRANSMIT-TIME <trans-time> <t-units>

Represents the time taken to transmit messages of the specified type. Time delays can cause queues to build up. The <trans-time> is a positive real number with <t-units> having units of (SEC), (MIN) or (HR).

1-WAY-PRIORITY <priority>

Normally a message is placed in a queue on a first-in first-out basis, but a prioritization number allows a message to be queued first according to priority and only then by time. Here <priority> is a positive integer, the higher the value of this integer the higher the priority of the message.

⁴ **ASGN-STAT** and **ENG-STAT** are synonyms and both should not appear in the same **NET TYPE** entry.

2.3. DEFINED-SHARED-ZONES

Defines a set of zones that may be accessed (or shared) by several SDB players. This data item occurs only once in the SDB and holds one or more **ZONE** data items. The **ZONE** data items defined here are accessible by several players, those belonging to only one player can be placed in a **ZONE** command embedded in a **PLAYER:** data item. Any player with access to a zone defined in **DEFINE-SHARED-ZONES** must have a **USE-SHARED-ZONE** defined in its **PLAYER:** data item. This gives the label and name of the particular **ZONE** data item referenced. The format for **DEFINE-SHARED-ZONES** is:

```
DEFINE-SHARED-ZONES
ZONE <id> <zone name> <horizontal-ref>
  MIN/MAX ALT: <min-alt> <min-units> <min-ref>
               <max-alt> <max-units> <max-ref>
  [Reference Phrase]
  {Horizontal Definition}
END DEFINE-SHARED-ZONES
```

<id> is a positive integer used for identification purposes along with <zone-name>.

This name is from the list of zones in the UAN. For shared zones a unique combination of label and type is required.

<horizontal-ref> is either **STATIONARY** or **RELATIVE**. If **STATIONARY** then the zone coordinates must be the absolute positions of the zone within the Suppressor coordinate system, choosing **RELATIVE** allows the coordinates to be entered relative to some location reference as described below.

<min-alt> and <max-alt> define the upper and lower vertical limits of the zone, they are real numbers with <min-units> and <max-units> as either **(M)**, **(KM)**, **(FT)**, **(MILES)**, **(NM)** or **(ANGELS)**. The altitudes are referred to <min-ref> and <max-ref> respectively, which can be **AGL** (above ground level), **MSL** (mean s level) or **REF** which is used when the zone is relative to some location.

[Reference Phrase] occurs zero or one time and only appears if <horizontal-ref> is set as **RELATIVE**. The use of this option overrides the default assumption that the location reference for a relative zone is a location of the player's location that owns the zone. There are four options:

Relative to a player

The specified player location must be on the list of perceived targets or on the list of friendly perceptions at the time of a zone evaluation for the evaluation to be successful. The format for the input is:

```
RELATIVE TO PLAYER: <id> <type> LOC: <loc-id>
```

<id> is the player label,

<type> is the player type from the list of players in the UAN, and

The Scenario Data Base

<loc-id> is the location label.

The Scenario Data Base

Relative to a checkpoint

The named checkpoint must be identified in the player's **PATH** or **PLANS-FOR-MOVEMENT** entries in the SDB and be present in the list of manoeuvres in the UAN. The format for input is:

```
RELATIVE TO CHECKPOINT: <checkpoint-name>
                        [HDG: <heading> <hdg-units>]
```

<checkpoint-name> is the name of the checkpoint
 <heading> is a real number giving the heading of the zone with
 <hdg-units> of either (DEG), (RADIANS) or (DEG/N/CW).
 The use of the heading qualifier is optional.

Relative to a position specified with Cartesian coordinates

The format for the input is:

```
RELATIVE TO X,Y,Z: <x> <y> <xy-units>
                  <z> <z-units> <alt-ref>
                  [HDG: <heading> <hdg-units>]
```

<x>, <y> and <z> are real numbers with
 <xy-units> are either (M), (KM), (FT), (MILES) or (NM), and
 <z-units> are either (M), (KM), (FT), (ANGELS), (MILES) or (NM)
 <alt-ref> is either AGL or MSL
 <heading> is a real number giving the heading of the zone with
 <hdg-units> of either (DEG), (RADIANS) or (DEG/N/CW).
 The use of the heading qualifier is optional.

Relative to a position specified using latitude and longitude

The format for the use of this option is:

```
RELATIVE TO L/L,Z: <latitude> <longitude>
                  <z> <z-units> <alt-ref>
                  [HDG: <heading> <hdg-units>]
```

<z> is a real number with
 <z-units> of either (M), (KM), (FT), (ANGELS), (MILES) or (NM)
 <alt-ref> is one of the following: AGL or MSL
 <heading> is a real number for the heading of the zone with
 <hdg-units> of either (DEG), (RADIANS) or (DEG/N/CW).
 The use of the heading qualifier is optional.

{Horizontal Definition}

This consists of one Circular Option or at least three Points Options.

The Scenario Data Base

Circular Option

Here the zone being defined is a sector of a circle if <min-rng> is zero is annular if <min-rng> is greater than zero. The centre of the zone is either the origin of the Suppressor system, or the position specified in the Reference Phrase or the location of the player relative to whom the zone is defined. The format for the input is:

MIN/MAX RNG:	<min-rng>	<max-rng>	<rng-units>
COUNTERCLOCKWISE FROM:	<angle-1>	<angle-units>	
TO:	<angle-2>	<angle-units>	

<min-rng> and <max-rng> define the width of the slice, they are non-negative real numbers with

<rng-units> of either (M), (KM), (FT), (MILES) or (NM).

<angle-1> and <angle-2> define the sides of the slice, they are real numbers with

<angle-units> of either (DEG), (RADIAN) or (DEG/N/CW). The range of the angles depends upon the units as summarised by the following table:

units	range
(DEG)	[-180°→180°]
(RADIAN)	[-π→π]
(DEG/N/CW)	[0°→360°]

N.B. the COUNTERCLOCKWISE qualifier is optional, if it is omitted the zone will be a complete circle.

Points Option

Each 'Points Option' describes a point and may be entered using either Cartesian or spherical coordinates. The following are the entry requirements:

1. the coordinates of the first point and last point must be different,
2. the points must define the edge of an enclosed polygon which is traversed in either a clockwise or anticlockwise sense, and
3. all point options do not have to use the same coordinate systems.

The format for entry is:

[point]	[point]	...
---------	---------	-----

where each point is entered as either:

X,Y:	<x>	<y>	<xy-units>
------	-----	-----	------------

<x> and <y> are real numbers with <xy-units> of either (M), (KM), (FT), (MILES) or (NM), or the point is specified in spherical coordinates as

L/L:	<latitude>	<longitude>
------	------------	-------------

The Scenario Data Base

with <latitude> and <longitude> using a DDDMMSSsd format.

2.4. SIDE

Defines each side of a scenario. Most scenarios will have two occurrences of **SIDE**, but at least one **SIDE** must always be present. Each **SIDE** contains one or more **COMMAND CHAIN** data items. A side can be declared neutral, but this is optional and can be omitted from the formatting below:

```
SIDE <side-name> [NEUTRAL]
      [COMMAND CHAIN]
END SIDE
```

<side-name> is from the list of sides in the UAN.

2.5. COMMAND CHAIN

Defines each different command chain and its constituent players that are going to make up each side present in the scenario. There must be at least one **COMMAND CHAIN** for each **SIDE** and each command chain must contain one or more **PLAYERS**:. The formatting is as follows:

```
COMMAND CHAIN <chain-name>
      [PLAYER:]
END COMMAND CHAIN
```

<chain-name> is from the list of command chains in the UAN.

2.6. PLAYER

There must be at least one **PLAYER:** data item for each player present in the scenario, but the same player may occur in several command chains. However a complete **PLAYER:** data item containing all the subsidiary information should only appear in the first **COMMAND CHAIN** in which the player appears. In each subsequent **COMMAND CHAIN** the **PLAYER:** data item should consist only of the 'Identification Phrase' which labels the player. The data items that can occur in the **PLAYER:** entry are:

- LOC:** at least one of these must appear for each **LOCATION** defined in the TDB for the current player's type.
- MODES-OF-CONTROL** optional, but if it does appear it can appear more than once to modify the player's tactics and utilization of its resources.
- ZONE** this may occur if the player has coordination tactics that are defined in terms of geographical volumes. It can appear more than once.

The Scenario Data Base

KNOWS this is used to give the player initial information about friendly players, is optional and can occur more than once.

TOLD ABOUT this is used to brief the player about hostile players. The information can be inaccurate. The item is optional and can appear more than once.

The format for **PLAYER:** and its embedded data items is:

```

PLAYER: <id> <player-name> LEVEL: <position>
      [(FOR DISAGGREGATION ONLY)] [(ALT-CMDRS:)]
      [LOC:]...
      [MODES-OF-CONTROL:]...
      [ZONES]...
      [KNOWS]...
      [TOLD ABOUT]...
END PLAYER

```

The Identification Phrase consists of:

PLAYER: <id> <player-name>

These two input values uniquely identify the player, <id> is a positive integer and <player-name> is from the list of players in the UAN and is also listed as a player type in the TDB. The number <id> does not have to be globally unique but must be unique to players of this type.

LEVEL: <position>

This is a positive integer from that describes where the player fits in the command chain structure. A player with a <position> of one would be the commander at the head of a command chain; one with the value two would be the second in command and so on. There will be at least one player whose position is one in any command chain but there could be more, all functioning as independent commanders of portions of the same chain

(FOR DISAGGREGATION ONLY)

This entry is optional and is only used for players who will be created through a disaggregation process, i.e. future players. The following are the guidelines to be followed when specifying **PLAYER:** definitions for resources that will disaggregate:

(1) Create a **PLAYER:** data item for each type of resource that will be disaggregated. Its identification phrase will have the following specifications,

PLAYER: <id> <player-name> (FOR DISAGGREGATION ONLY)

which is a template for the creation of some variable number of future players. Upon launch or firing of the particular resource, the model will use the specified <id> for the first player it creates then the <id> will be incremented by one for each subsequent player.

(2) Place the **PLAYER:** data item in all command chains in which the players of such type will exist.

The Scenario Data Base

ALT-CMDRS:

This entry is optional and is used to name one or more subordinates as alternative commanders. The subordinates must initially be one level below the commander in the command structure and possess a means of communicating with other players. The entry has the format:

ALT-CMDRS: COMMAND-CHAIN <chain-name> <player-id> <player-name>

2.7. LOC

The **LOC:** entry defines both where each player's locations are to be found within each scenario and also is used to initialize the component elements to be found at each location through embedded data items. Players may have more than one location as described in the **PLAYER-STRUCTURE** in the TDB. The data items that can be embedded in **LOC:** are:

ELEMENT: this is not required, but if it is present it must be placed first and occur once each for every element to be found at this **LOCATION** in the **PLAYER-STRUCTURE** for this player's type in the TDB

PLANS-FOR-MOVEMENT occurs at most once. It is used for players that can only reactively move.

PATH occurs at most once. It is used for a player that has at least a partially predetermined path at the start of the game. **PLANS-FOR-MOVEMENT** and **PATH** cannot both be present at the same time

The format for using **LOC:** is:

LOC: <id> {Location Definition} <heading> [ELEMENT:] ... [PLANS-FOR-MOVEMENT] [PATH] END LOCATION

<id> is a positive integer and must match the associated <loc-id> found in the **PLAYER-STRUCTURE** data item of the TDB.

{Location Definition} provides the initial physical location.

<heading> is optional and allows the orientation of non-moving elements in a direction other than in the default of due east. It has the following format:

HDG: <hdg> <hdg-units>

<hdg> is a real number specifying the heading angle with <hdg-units> chosen from either (DEG), (RADIAN) or (DEG/N/CW).

The Scenario Data Base

2.8. ELEMENT

This is the largest embedded item within each location of the player. It is used both to make small alterations to the status of each element from the proto-type defined in the TDB **PLAYER-STRUCTURE** and to initialize each element through further embedded data items. The element is first identified through its label, <id>, and its name, <element-name>, as specified in the TDB. Then the element's ability to survive attacks can be changed from that specified in the TDB by giving either of the keywords **DISCRETE** or **CONTINUOUS** which give the element's nature. These are followed by the keyword **QUANTITY:** and a either an integer value, for **DISCRETE** natured elements, or a real value, for **CONTINUOUS** natured elements. These values affect the element's chance of surviving an attack as follows:

DISCRETE, integer valued quantity: a random number is selected when the element is attacked, the probability of a successful attack. If this number is less than some user defined threshold, (which varies according to the circumstances of the attack and the weapon used and is known as the probability of kill or P_K), then a 'kill' is recorded and the value decremented by unity. When this value reaches zero the element is completely destroyed. Otherwise it is considered to survive and remain functional.

CONTINUOUS, real valued element: this represents the element's cumulative survival probability. After each new attack it is multiplied by the complement of P_K , which is the probability of the element surviving the attack. Note that while this value may become very small it will not reach zero and so players of this type will always remain within the scenario.

Next either of the keywords **CRITICAL** or **NONCRITICAL** can be specified to indicate whether or not destruction of this element is critical to the whole location's survival.

The format for the command is:

```
ELEMENT: <id> <element-name> <nature> QUANTITY: <quantity>
        {<criticality>}
        [SYSTEM:] ...
END ELEMENT
```

<id> and <element-name> correspond to <ele-id> and <ele-name> in the TDB **PLAYER-STRUCTURE**,
 <nature> is either **DISCRETE** or **CONTINUOUS**
 <quantity> is a positive integer if <nature> is **DISCRETE** and a positive real number if it is **CONTINUOUS**,
 <criticality> is optional and is either.

Changes in <nature>, <quantity> or <criticality> will override the TDB values for these inputs. Both the <nature> and the <quantity> items must be given even if they are the same as for the TDB entry, which makes the TDB items redundant.

The Scenario Data Base

The <criticality> element is optional and so if not given the TDB value will be used. The embedded data item [SYSTEM:] occurs zero or more times and can be used to set the status of the element's component systems.

2.9. SYSTEM

Defines differences in status of an element's system from those defined in **PLAYER-STRUCTURE** in the TDB for the corresponding player type. This is an optional data item and it too has embedded data items:

TURN: occurs zero or more times and is used to turn systems on and off at different times in the scenario.

POINT IT: occurs zero or one time and forces the system to point in a certain direction.

FREQ: for sensors transmitters and receivers this appears at most once, for communication receivers it occurs zero or more times and is used to set operating frequencies.

ALT-FREQ: occurs zero or more times for communication receivers to give alternative operating frequencies.

FOCUS: occurs zero or more times for a disruptor system, and is used to define pre-emptive jamming spots which can be focussed on targetted transmitter's frequencies.

The format for the input is:

SYSTEM: <id> <system-name> <system-status> [TURN] ... [POINT IT] [FREQ:] ... [ALT-FREQ:] ... [FOCUS] ...

The first line of input is known as the system sentence and it identifies the system for which new information is being entered. There are three required entries: <id>, <system-name> and <system-status>. The first two correspond to the system's label and name specified in the **PLAYER-STRUCTURE** template found in the TDB. The <system-status> is one of the following:

ON generally used to indicate that the system is operating normally.

OFF causes the system to start the simulation turned off, which can be changed turned on later.

NON-OP causes the system to remain completely non-operational for the whole simulation.

The Scenario Data Base

The default initial status is **OFF** for sensor receivers having only tracking capability and **ON** for all other systems.

The data items **TURN**, **POINT IT**, **FREQ:**, **ALT-FREQ:** and **FOCUS** are all described in detail below. If one of these data items needs to be defined or the initial system status is other than the default the **SYSTEM:** data item is required otherwise it can be omitted.

2.10. TURN

This allows systems to be turned on and off or made non-operational at predetermined moments during the scenario. It is normally used for jammers and disruptors and sometimes for sensors, the use of this data item is optional and the format for the input is:

```
TURN <system-status> AT TIME: <time> <units>
```

<system-status> is one of the following: **ON**, **OFF** or **NON-OP**,

<time> is a positive real number and denotes when during a scenario the status change will take effect, with <units> of either **(SEC)**, **(MIN)** or **(HR)**.

N.B. **TURN** should not be used to specify the system's status at the start of the scenario, the **SYSTEM:** data item should be used instead.

2.11. POINT IT

Orients a system to point in a specific direction or point at a certain place during the scenario execution. It is used mainly for disruptors and communication transmitters and receivers and its use is optional, but if it does appear it can appear at most once. There are two options for the use of this item as described below:

POINT IT IN

This allows a system to be pointed in a given direction. The format is:

```
POINT IT IN <direction> DIR AZ, EL: <azimuth> <elevation>  
<az-el-units> [<fix/target>]
```

<direction> can be either **ABS** (absolute) or **REL** (relative) to the heading of the parent location,

<azimuth> is a non-negative real number from the range $[0.0, 2\pi]$ or $[0^\circ, 360^\circ]$ measured anticlockwise from due east,

<elevation> is a real number from the range $[-\pi/2, \pi/2]$ or $[-90^\circ, 90^\circ]$,

<az-el-units> are either **(DEG)** or **(RADIANS)**,

The Scenario Data Base

<fix/target> is optional and is either **FIXED** or **TARGET** and is only applicable to sensor receivers.

If the direction is specified as **REL** and the system is on a moving vehicle, it will point in the direction that is measured relative to the heading of the moving vehicle. If the direction is specified as **ABS** and the system is on a moving vehicle, it will always point in this direction regardless of the orientation of the moving system. Stationary objects have a default setting of east. NB: the **HDG:** option of **LOC:** can be used to change the default due east reference direction. For sensor receivers selecting the option **FIXED** ensures that the system always points as described in the **POINT IT IN** statement. If this option is omitted or if the entry **TARGET** is selected a sensor receiver in tracking mode or on board a location that is moving to engage a target will point at the target.

POINT IT AT LOCATION

This option causes the system to always be directed at a specific point in the coordinate system. The format for its use is:

```
POINT IT AT LOCATION {Location Definition}
```

Even if the system is on a moving vehicle it will always point at the defined location no matter how the vehicle moves. {Location Definition} specifies the point location using either Cartesian or spherical coordinates.

The format for the point's entry using Cartesian coordinates is:

```
X,Y,Z: <x> <y> <xy-units> <z> <z-units> <altitude-ref> [<fix/target>]
```

Here <x>, <y> and <z> are real numbers and
 <xy-units> of either **(M)**, **(KM)**, **(FT)**, **(MILES)** or **(NM)**,
 <z-units> of either **(M)**, **(KM)**, **(FT)**, **(MILES)**, **(NM)** or **(ANGELS)**
 <altitude-ref> is either **AGL** for above ground level or **MSL** for mean sea level.
 <fix/target> is optional and is either **FIXED** or **TARGET** and is only applicable to sensor receivers. It carries the same meaning as for the **POINT IT IN** statement.

The point may be specified using spherical coordinates as follows:

```
L/L,Z: <latitude> <longitude> <z> <z-units> <altitude-ref> [<fix/target>]
```

with <latitude> and <longitude> using a DDDMMSSsd format and the other options having the same meanings as above.

The Scenario Data Base

2.12. FREQ

Defines the primary operating frequency for a sensor receiver, sensor transmitter, or a communication receiver. For a communication receiver, this item also specifies the communication net to which the receiver belongs when used with this frequency. The formatting is different for sensor and communication systems:

Sensor Systems:

For radar sensors this data item should appear at most once within the **SYSTEM:** item naming the sensor receiver or transmitter system. For optical sensors the data item may appear within a **SYSTEM:** item naming the sensor receiver. In either case the frequency specified here overrides the **XMIT-FREQ** in the system's capability block in the TDB. The format for its input is:

```
FREQ: <frequency> <units>
```

<frequency> is a positive real number with
<units> of either (HZ), (KHZ), (MHZ) or (GHZ)

Communication Systems:

If a communications receiver is named in the **SYSTEM:** data item then the **FREQ:** data item is required for every different communication net a player is going to use this receiver on. The format for communication systems:

```
FREQ: <frequency> <units> NET: <net-id> <net name>
```

<frequency> is a positive real number with
<units> as either (HZ), (KHZ), (MHZ) or (GHZ)
<net-id> is a positive integer and
<net-name> is from the list of implicit-nets or explicit-nets in the UAN and corresponds to a net defined in one of the **NET TYPE** data items in the SDB. The frequency assigned to implicit nets is a dummy frequency with no physical significance.

2.13. ALT-FREQ

Defines alternative frequencies for a communication receiver, sensor receiver, or sensor transmitter so that the system can change to a new frequency in response to jamming. The format for the input is:

```
ALT-FREQ: <id> <alt-frequency> <units>
```


The Scenario Data Base

<id> is a positive integer for identification purposes. It identifies the alternative frequency and also specifies a relative ordering of the frequencies. The identifiers should be given in ascending order.

<alt-frequency> is a positive real number giving the alternative frequency with <units> of either (HZ), (KHZ), (MHZ) or (GHZ).

One **FREQ:** sentence must precede the set of **ALT-FREQ:** sentences. It is advisable to have at least one **ALT-FREQ:** data item defined for each communication net but only one player on a net should have the **ALT-FREQ:** definitions.

2.14. FOCUS

Used to define zero or more pre-emptive spots for a disruptor system. Pre-emptive spots are focused upon certain frequency bands immediately upon the turning on of an explicit jammer. The format for the input is:

FOCUS	NOISE	SPOT	LO/HI-FREQ:	<low-freq>	<high-freq>	<units>
	PULSE					

with <low-freq> and <high-freq> are real values specifying the frequency band with <units> of either (HZ), (KHZ), (MHZ) or (GHZ).

N.B. **PULSE** jammer spots require a value for **SUBCARRIER-BANDWIDTH** in **DISRUPTOR-FREQ-LIMITS** to be set in the TDB.

2.15. PLANS FOR MOVEMENT

This data item follows the embedded items which define each element at the current location. It allows the user to specify movement plans for the player's location when it has no predefined movement path defined in a **PATH** data item. (So that this player can only reactively manoeuvre.) It is required for locations that are going to start movement at some time during the scenario with the particular movement plans specified in the **MOVE-PLANS** data item in the TDB. If **PLANS-FOR-MOVEMENT** is given for a player then the **PATH** item must be absent. The **PLANS-FOR-MOVEMENT** item is commonly used for disaggregated players, i.e. future players.

The Scenario Data Base

The **PLANS-FOR-MOVEMENT** data item consists of one or more path points, each point is described by the use of five components. The format for the input is given below and is followed by a description of the various components:

```

PLANS-FOR-MOVEMENT
  PLAN <plan-name> (...<actual-argument>...)
  CHECKPOINT <checkpoint-name>
  {Location Definition}
  SPD: <speed> <sp-units>
  TURN-RADIUS: <radius> <rad-units>
  .
  .
  .
END PLANS-FOR-MOVEMENT

```

Plan Entry

Each named **PLAN** constitutes a 'Plan Entry' in the SDB. This entry directs the model to invoke a particular named plan from the **MOVE-PLANS** tactics at that point. It consists of a:

<plan-name> from the list of manoeuvres in the UAN. The plan name provides a linkage from the SDB to a particular plan in a **MOVE-PLANS** data item so this name must be identical to one given in **MOVE-PLANS**.

<actual-argument> occurs zero or more times from the list of manoeuvres in the UAN. There is a space required both before and after the value list inside the parentheses, the parentheses are absent if these options are absent. This option allows data specified in the SDB for each individual player to be passed to the plan, which is defined only once for each player-type, so varying its behaviour from player to player.

Checkpoint Entry

This entry provides a means of associating the physical location given in the 'Location Definition' which follows it to a checkpoint specified in the current plan from player-type's **MOVE-PLANS** block. At least one 'Plan Entry' or 'Checkpoint Entry' must be provided for each 'Location Definition' in order for the player to identify the point with a particular plan. The entry consists of:

<checkpoint-name> a checkpoint name taken from the list of manoeuvres in the UAN.

Location Definition

Provides the coordinates of a point somewhere along the player's path, with these points requiring no special order. Each point must have a 'Plan Entry' and or a 'Checkpoint Entry' preceding it. At least one 'Location Definition' requires a plan name to precede it, but it does not need to be the first point in the list. The location definition can occur zero or more times, but should occur at least once for the **PLANS-FOR-MOVEMENT** entry to have any effect. If the point is specified using Cartesian coordinates it has format:

```

X,Y,Z: <x> <y> <xy-units> <z> <z-units>

```

The Scenario Data Base

Here $\langle x \rangle$, $\langle y \rangle$ and $\langle z \rangle$ are real numbers and
 $\langle xy\text{-units} \rangle$ of either (M), (KM), (FT), (MILES) or (NM),
 $\langle z\text{-units} \rangle$ of either (M), (KM), (FT), (MILES), (NM) or (ANGELS)

If the point is specified using spherical coordinates it has format as follows:

L/L,Z: $\langle \text{latitude} \rangle$ $\langle \text{longitude} \rangle$ $\langle z \rangle$ $\langle z\text{-units} \rangle$
--

with $\langle \text{latitude} \rangle$ and $\langle \text{longitude} \rangle$ using a DDDMMSSsd format and the other options having the same meanings as above.

Speed Entry

This may occur after any point and gives the speed the player in moving from the current point to the next. Its format is:

SPD: $\langle \text{speed} \rangle$ $\langle \text{sp-units} \rangle$

where $\langle \text{speed} \rangle$ a positive real number with

$\langle \text{sp-units} \rangle$ of either (M/SEC), (KM/HR), (FT/SEC), (MPH) or (KNOTS).

Turn Radius Entry

This entry may occur after a 'Location Definition' for a path whose mode is set to be 3-D and gives the player's minimum turn radius in moving from the current point to the next. Its format is:

TURN-RADIUS: $\langle \text{radius} \rangle$ $\langle \text{rad-units} \rangle$

where $\langle \text{radius} \rangle$ is a positive real number with

$\langle \text{rad-units} \rangle$ as either (M), (KM), (FT), (MILES) or (NM).

It is important to note that the inclusion of a speed and or a turn radius after the first 'Location Definition' for a disaggregated player, i.e. a future player, will define the initial speed and or turn-radius for the player upon its creation. If these values are not specified then the default speed and turn radius are 1 ms^{-1} and 1 m, respectively. These values are unlikely to be ones required for the player so normally these entries will be required for disaggregated players. Also note that reactive movement can cause changes in the speed and turn radius independently of the changes specified in this data item.

2.16. PATH

This data item is required for locations that move along a predefined movement path, but the player may still reactively manoeuvre if required to do so by the model. If PATH is given for a player then the PLANS-FOR-MOVEMENT item must be absent. The PATH command is not suitable for players who will be launched into motion following a command from a superior. The format for the input is:

PATH START TIME $\langle \text{time} \rangle$ $\langle \text{t-units} \rangle$ ALT: $\langle \text{altitude-ref} \rangle$ MODE: $\langle \text{mode} \rangle$
--

The Scenario Data Base

[BOUNDARY] {Point Data} {Point Data} ...

<time> is a non-negative real number with units of either (SEC), (MIN) or (HR).

The time defines when the player location begins movement and should be greater than or equal to the game **START TIME** .

<altitude-ref> is either **AGL** or **MSL**, although these are equivalent when no terrain is present. This specifies the interpretation of the z-coordinates given in the Point Data entries.

<mode> is either

SURFACE which models point-to-point movements using straight line segments which include instantaneous changes of direction or
3-D which models the movement using smooth curves which cannot make turns with radii smaller than the specified minimum turn radius. The arcs constituting the turns are three dimensional.

[BOUNDARY] is an optional embedded data item that defines spatial limits for an entire path, not just for path segments. It is required when one of the following is specified in the TDB **MOVE-OPTIONS** data item: Terrain Following, Terrain Avoidance or Threat Avoidance. It is also required if the **NOW-TERRAIN-FOLLOW** action is used in the TDB **MOVE-PLANS**. A maximum of one **BOUNDARY** entry can appear in **PATH**. See below for a description of the **BOUNDARY** data item.

{Point Data} There are six components for describing each point, as shown in the format statement below. If the player can reactively manoeuvre then all components of the point data format may be used. If the player only follows preprogrammed paths then the plan entry and checkpoint entry are not used. The first point in a movement path must include a location definition and a speed entry. It must also possess a plan entry if the moving location can reactively manoeuvre to engage targets. The format is shown below:

PLAN <plan-name> (...<actual-argument>...) CHECKPOINT <checkpoint-name> {Location Definition} SPD: <speed> <sp-units> TURN-RADIUS: <radius> <rad-units> TIME-WINDOW: <min-time> <max-time> <t-units>

Plan Entry

Each named **PLAN** constitutes a 'Plan Entry' in the SDB. This entry directs the model to invoke a particular named plan from the **MOVE-PLANS** tactics at that point. It consists of a:

<plan-name> from the list of manoeuvres in the UAN. The plan name provides a linkage from the SDB to a particular plan in a **MOVE-PLANS** data item so this name must be identical to one given in **MOVE-PLANS**.

The Scenario Data Base

<actual-argument> occurs zero or more times from the list of manoeuvres in the UAN. There is a space required both before and after the value list inside the parentheses, the parentheses are absent if these options are absent. This option allows data specified in the SDB for each individual player to be passed to the plan, which is defined only once for each player-type, so varying its behaviour from player to player.

Checkpoint Entry

This entry provides a means of associating the physical location given in the 'Location Definition' which follows it to a checkpoint specified in the current plan from player-type's **MOVE-PLANS** block. At least one 'Plan Entry' or 'Checkpoint Entry' must be provided for each 'Location Definition' in order for the player to identify the point with a particular plan.. The entry consists of:

<checkpoint-name> is a checkpoint name taken from the list of manoeuvres in the UAN.

Location Definition

Provides the coordinates of the points making up the player's preprogrammed path. At least two points are required to form a path. For points which are part of a plan for reactive movement then either a 'Plan Entry' or a 'Checkpoint Entry' or both should precede it. At least one 'Location Definition' requires an identified plan to precede it, but it does not need to be the first point in the list. If the point is specified using Cartesian coordinates it has format:

X,Y,Z: <x> <y> <xy-units> <z> <z-units>

Here <x>, <y> and <z> are real numbers and

<xy-units> of either (M), (KM), (FT), (MILES) or (NM),

<z-units> of either (M), (KM), (FT), (MILES), (NM) or (ANGELS)

If the point is specified using spherical coordinates it has format as follows:

L/L,Z: <latitude> <longitude> <z> <z-units>

with <latitude> and <longitude> using a DDDMMSSsd format and the other options having the same meanings as above.

Speed Entry

This must occur after the first point to specify the initial speed of the player and then may occur after any subsequent point to change the speed of the player. Its format is:

SPD: <speed> <sp-units>

where <speed> is a positive real number with

<sp-units> of either (M/SEC), (KM/HR), (FT/SEC), (MPH) or (KNOTS).

Turn Radius Entry

This entry must occur after the first point to specify the minimum turn radius of a player whose path is being computed using the 3-D mode. It may occur

The Scenario Data Base

after any subsequent point to change the minimum turn radius of the player.
Its format is:

TURN-RADIUS: <radius> <rad-units>

where <radius> is a positive real number with
<rad-units> as either (M), (KM), (FT), (MILES) or (NM).

Time Entry

This entry may be given after any point in order to attempt to constrain the mover to arrive at the specified point in the desired time window. This will only be achievable if the speeds at which the player must move in order to accomplish this are consistent with the player's speed and acceleration limits.

Its format is:

TIME-WINDOW: <min-time> <max-time> <t-units>

<min-time> and <max-time> are positive real numbers which bound the time interval with units <t-units> of (SEC), (MIN) or (HR).

Note that any reactive movement can cause changes in the speed and turn radius independently of the changes specified in this data item.

2.17. BOUNDARY

Places vertical and horizontal limits on movement when using terrain following, terrain avoidance and threat avoidance modes. There must be a MOVE-OPTIONS data item present in the TDB defining the movement modes for the associated player type. This data item consists of a 'Vertical Phrase' and a 'Horizontal Phrase' with the following format:

BOUNDARY VERTICAL LIMIT: MIN <z> <z-units> AGL MAX <z> <z-units> MSL {Location Definition} {Location Definition} {Location Definition} ...
--

Vertical Phrase

This is required for a moving player location that uses terrain following or terrain avoidance. It has no effect when used with threat avoidance but must still be present. This phrase consists of vertical limits which defines the band of altitudes within which the player location is allowed move.

<z> is a real number with

<z-units> of either (M), (KM), (FT), (MILES) or (ANGELS).

Note that the lower limit must be given relative to ground level, AGL, and the upper limit relative to mean sea level, MSL.

The Scenario Data Base

Horizontal Phrase

This is required for a moving player location that uses any of the three modes. It consists of three or more points. The points' positions may be entered using either Cartesian co-ordinates or spherical coordinates. Together they define the perimeter of a polygon which defines the region within which the player must remain. The points must be ordered so that they either describe the boundary of the polygon in a clockwise or anticlockwise sense with the coordinates of the first point and the last point being different. Each point is entered in Cartesian coordinates as:

X,Y: <x> <y> <xy-units>

<x> and <y> are real numbers with <xy-units> of either (M), (KM), (FT), (MILES) or (NM), or if the point is specified in spherical coordinates as

L/L: <latitude> <longitude>

with <latitude> and <longitude> using a DDDMMSSsd format.

2.18. MODES OF-CONTROL

This entry initializes the player's modes of control for decisions involving launching subordinates, lethal engagement, non-lethal engagement and emission control. This entries can be tested in the player's tactical decision making procedures. There are four possible entries in this data item and each requires a single entry of the name of the player which has the decision making authority. The format of the command is as shown below:

MODES OF CONTROL	
LAUNCH	<player-name>
ENGAGE	<player-name>
DISRUPT	<player-name>
EMCON	<emcon-player-name>

<player-name> comes from the list of players in the UAN and

<emcon-player-name> is either CMDR or from the list of players in the UAN.

MODES-OF-CONTROL is used in conjunction with selected criteria in the TDB RESOURCE ALLOCATION data item, as follows:

LAUNCH	<player-name>	LAUNCH-CONTROL-MODE	IS	<player-name>
			IS-NOT	SELF
ENGAGE	<player-name>	ENG-CONTROL-MODE	IS	<player-name>
			IS-NOT	SELF
DISRUPT	<player-name>	JAM-CONTROL-MODE	IS	<player-name>

The Scenario Data Base

	IS-NOT	SELF
--	--------	------

NB: EMCON mode of control cannot be evaluated in RESOURCE ALLOCATION presently.

2.19. ZONE

Defines a volume for a zone. A player who has tactics effected by permissions in ZONE-CHARACTERISTICS or has a RESOURCE-ALLOCATION criteria referring to a zone needs to have that zone described either in a ZONE data item or in a DEFINE-SHARED-ZONES data item. If only the player under consideration will use the zone then a ZONE data item should be created; otherwise if more than one player will access the same zone, a DEFINE-SHARED-ZONES data item should be defined in the SDB. Access to the shared zone is accomplished by including the USED-SHARED-ZONE (described next) for each player with access. The format for zone is the same regardless of where it is included:

```

ZONE <id> <zone name> <horizontal-ref>
  MIN/MAX ALT: <min-alt> <min-units> <min-ref>
               <max-alt> <max-units> <max-ref>
  [Reference Phrase]
  {Horizontal Definition}

```

<id> is a positive integer used for identification purposes along with <zone-name>.

This name is from the list of zones in the UAN. For zones owned by only one player the label should be unique.

<horizontal-ref> is either STATIONARY or RELATIVE. If STATIONARY then the zone coordinates must be the absolute positions of the zone within the Suppressor coordinate system, choosing RELATIVE allows the coordinates to be entered relative to some location reference as described below.

<min-alt> and <max-alt> define the upper and lower vertical limits of the zone, they are real numbers with <min-units> and <max-units> as either (M), (KM), (FT), (MILES), (NM) or (ANGELS). The altitudes are referred to <min-ref> and <max-ref> respectively, which can be AGL (above ground level), MSL (mean s level) or REF which is used when the zone is relative to some location.

[Reference Phrase] occurs zero or one time and only appears if <horizontal-ref> is set as RELATIVE. The use of this option overrides the default assumption that the location reference for a relative zone is a location of the player's location that owns the zone. There are four options:

The Scenario Data Base

Relative to a player

The specified player location must be on the list of perceived targets or on the list of friendly perceptions at the time of a zone evaluation for the evaluation to be successful. The format for the input is:

```
RELATIVE TO PLAYER: <id> <type> LOC: <loc-id>
```

<id> is the player label,

<type> is the player type from the list of players in the UAN, and

<loc-id> is the location label.

Relative to a checkpoint

The named checkpoint must be identified in the player's **PATH** or **PLANS-FOR-MOVEMENT** entries in the SDB and be present in the list of manoeuvres in the UAN. The format for input is:

```
RELATIVE TO CHECKPOINT: <checkpoint-name>
                        [HDG: <heading> <hdg-units>]
```

<checkpoint-name> is the name of the checkpoint

<heading> is a real number giving the heading of the zone with

<hdg-units> of either (DEG), (RADIANS) or (DEG/N/CW).

The use of the heading qualifier is optional.

Relative to a position specified with Cartesian coordinates

The format for the input is:

```
RELATIVE TO X,Y,Z: <x> <y> <xy-units>
                  <z> <z-units> <alt-ref>
                  [HDG: <heading> <hdg-units>]
```

<x>, <y> and <z> are real numbers with

<xy-units> are either (M), (KM), (FT), (MILES) or (NM), and

<z-units> are either (M), (KM), (FT), (ANGELS), (MILES) or (NM)

<alt-ref> is either AGL or MSL

<heading> is a real number giving the heading of the zone with

<hdg-units> of either (DEG), (RADIANS) or (DEG/N/CW).

The use of the heading qualifier is optional.

Relative to a position specified using latitude and longitude

The format for the use of this option is:

```
RELATIVE TO L/L,Z: <latitude> <longitude>
                  <z> <z-units> <alt-ref>
                  [HDG: <heading> <hdg-units>]
```

The Scenario Data Base

<z> is a real number with
 <z-units> of either (M), (KM), (FT), (ANGELS), (MILES) or (NM)
 <alt-ref> is one of the following: AGL or MSL
 <heading> is a real number for the heading of the zone with
 <hdg-units> of either (DEG), (RADIANS) or (DEG/N/CW).
 The use of the heading qualifier is optional.

{Horizontal Definition}

This consists of one Circular Option or at least three Points Options.

Circular Option

Here the zone being defined is shaped like a piece of pie (if <min-rng> is zero) or a like a doughnut (if <min-rng> is greater than zero). The centre of the zone is either the origin of the Suppressor system, or the position specified in the Reference Phrase or the location of the player relative to whom the zone is defined. The format for the input is:

MIN/MAX RNG:	<min-rng>	<max-rng>	<rng-units>
COUNTERCLOCKWISE FROM:	<angle-1>	<angle-units>	
TO:	<angle-2>	<angle-units>	

<min-rng> and <max-rng> define the width of the slice, they are non-negative real numbers with
 <rng-units> of either (M), (KM), (FT), (MILES) or (NM).
 <angle-1> and <angle-2> define the sides of the slice, they are real numbers with
 <angle-units> of either (DEG), (RADIANS) or (DEG/N/CW). The range of the angles depends upon the units as summarised by the following table:

units	range
(DEG)	$[-180^{\circ} \rightarrow 180^{\circ}]$
(RADIANS)	$[-\pi \rightarrow \pi]$
(DEG/N/CW)	$[0^{\circ} \rightarrow 360^{\circ}]$

N.B. the COUNTERCLOCKWISE qualifier is optional, if it is omitted the zone will be a complete circle.

Points Option

Each 'Points Option' describes a point and may be entered using either Cartesian or spherical coordinates. The following are the entry requirements:

1. the coordinates of the first point and last point must be different,
2. the points must define the edge of an enclosed polygon which is traversed in either a clockwise or anticlockwise sense, and

The Scenario Data Base

3. all point options do not have to use the same coordinate systems.
The format for entry is:

[point] [point] ...

where each point is entered as either:

X,Y: <x> <y> <xy-units>

<x> and <y> are real numbers with <xy-units> of either (M), (KM), (FT), (MILES) or (NM), or the point is specified in spherical coordinates as

L/L: <latitude> <longitude>

with <latitude> and <longitude> using a DDDMMSSsd format.

2.20. USE-SHARED-ZONES

Allows a player to have access to a zone that is also used by other players and is defined in a **DEFINE-SHARED-ZONES** data item. Each zone that a player will access requires a **USE-SHARED-ZONE** data item to identify the particular zone entry. The format for this is:

USE-SHARED-ZONE <id> <zone-name>

<id> is a positive integer number and

<zone-name> is from the list of zones in the UAN.

These two entries must match those defined for the **ZONE** data item that is to be shared.

2.21. KNOWS

This data item allows each player to be given initial information about friendly players and allow it to know what materiel that player has under its control. (Here material is always either a player or future player resource.) It is an optional data item and consists of two types of entry as shown in the format below:

KNOWS: <id> <player-name> <status> {Location Definition}
HAS <materiel-amount> <materiel-type>

Knows Entry

This can be used alone or followed by a 'Has Entry'. It is used to provide either true or misperceived locations of friendly players. The entries are:

The Scenario Data Base

<id> and <player-name> which identify the friendly player and must correspond to identical entries made in the **PLAYER:** data item for the known player.

<status> is either **O/A** (out of action) or **OP** (operational)

The physical location may be given using either Cartesian coordinates with format:

X,Y,Z: <x> <y> <xy-units> <z> <z-units> <altitude-ref>
--

Here <x>, <y> and <z> are real numbers and

<xy-units> of either **(M)**, **(KM)**, **(FT)** or **(MILES)**,

<z-units> of either **(M)**, **(KM)**, **(FT)**, **(MILES)** or **(ANGELS)** and

<altitude-ref> is either **AGL** for above ground level or **MSL** for mean sea level.

If the point is specified using spherical coordinates it has format as follows:

L/L,Z: <latitude> <longitude> <z> <z-units> <altitude-ref>
--

with <latitude> and <longitude> using a DDDMMSSsd format and the other options having the same meanings as above.

Has Entry

This cannot be used alone. A Knows/Has combination is required for a commander in a command chain who has the authority to launch other players. The 'Has Entry' is used to list the number and type of resources for launching. The entries are:

<materiel-amount>, a positive integer defining the quantity of materiel at the player's location, and

<materiel-type> which identifies the resource from the list of players or future-players in the UAN.

N.B. when using the above entries in combination the following are required:

- (i) there must be a 'Knows Entry' for each subordinate to be used in the process for launching;
- (ii) the subordinates which possesses the material to be launched, i.e. the subordinate which includes a 'Has Entry', must have status **OP** whilst the subordinates that are to be launched must have status **O/A**;
- (iii) the physical locations must be identical for all the subordinate in the chain.

The Scenario Data Base

The following example clarifies these rules. It shows the **KNOWS** entry for a commander indicates that it has a subordinate '341 airbase' that is operational and has interceptors of type 'fighter_player', currently out of action, that could potentially be launched as a resource.

```
KNOWS 71 fighter_player O/A
  X,Y,Z: -200.0 190.0 (KM) 0.0 (M) AGL
KNOWS 341 airbase OP
  X,Y,Z: -200.0 190.0 (KM) 0.0 (M) AGL
  HAS 6 fighter_player
```

2.22. TOLD ABOUT

Sets up briefed perceptions of threats, i.e. enemy players, which may be engaged or may influence threat avoidance. Perceptions created here are permanent and will only be dropped when the target is believed to be dead. The data may be accurate or inaccurate. **TOLD ABOUT** can appear as many times as necessary with the format:

```
TOLD ABOUT <id> <player-name> LOC <loc-id>
{Location Definition}
BY <intell-id> <intell-name>
```

<id>, <player-name> <loc-id> correspond to the identical values specified in the **PLAYER:** and **LOC:** data items.

<intell-id> and <intell-name> identify the player providing the intelligence information and the values must correspond to the label and player name given in the **PLAYER:** data item of the SDB.

The physical location may be given using Cartesian coordinates with format:

```
X,Y,Z: <x> <y> <xy-units> <z> <z-units> <altitude-ref>
```

Here <x>, <y> and <z> are real numbers and

<xy-units> of either (M), (KM), (FT) or (MILES),

<z-units> of either (M), (KM), (FT), (MILES) or (ANGELS) and

<altitude-ref> is either **AGL** for above ground level or **MSL** for mean sea level.

If the point is specified using spherical coordinates it has format as follows:

```
L/L,Z: <latitude> <longitude> <z> <z-units> <altitude-ref>
```

with <latitude> and <longitude> using a DDDMMSSsd format and the other options having the same meanings as above.

Time History Data Items

3. Time History Data Items

This section contains a list of time history data items with each entry accompanied by a brief description. These data items are referred to in the ADB and MOD sections. The full syntax of many entries is similar to that of **CAN'T-USE-NEW-DETECTION-OF** which is given here as an example:

```
<player-id> <player-name> [<location-id>]
      CAN'T-USE-NEW-DETECTION-OF
<player-id> <player-name> [<location-id>]
```

In this entry the first name triplet <player-id>, <player-name> and [<location-id>] refer to the SDB label, the player name and, when the player has more than one location, the label of the relevant location. For conciseness the above syntax will be recorded in this appendix as follows:

```
first-player CAN'T-USE-NEW-DETECTION-OF second-player
```

Usually the meaning of the items is self explanatory, but in some cases extra information is recorded in the output. In this case a fuller explanation of the format used and the information contained in the data will be given. Most times given in the entries refer to 'game time' and are expressed in an HH:MM:SS.s format, where HH are hours, MM are minutes, SS are seconds and s are tenths of seconds. Spatial positions are given in Cartesian co-ordinates in units of kilometres. Where given angles are expressed in degrees. Azimuthal angles and headings are measured clockwise from due north, this differing from the conventions in the TDB and SDB where they are measured anticlockwise from due east.

In the MOD output each entry is listed in chronological order with the time of the entry being listed first, for example the following example occurs just after six minutes game time have elapsed:

```
6:01.8
11 bomber INITIATES-PERCEPTION-OF 101 target
   and FIRST-DIRECTLY-SEES it
   with sensor: 120 bomber_radar_rx; tgt (x,y,z): 19.000 10.500 0.000
   km; at time: 6:01.6; spd: 0.0 m/s; hdg: 90.0 deg; sense time:
   6:01.6; sensor (x,y,z): -15.3 14.2 1.200 km; 3-D dist: 34.6 km
```

From this example it is clear that several entries can be run together, slightly modifying their format. This is not discussed in the following descriptions of the individual entries but when it occurs in a listing file the sense of the entry should always be clear.

Time History Data Items

ABANDONS-SALVOING-AGAINST

This entry records that salvo firing has been aborted due to an event beyond the control of the attacker:

first-player **ABANDONS-SALVOING-AGAINST** second-player

ABORTED-INFLIGHT-SHOT-AT

Documents the loss of controlled ordnance enroute to a target due to one of the following reasons:

- ◆ the tracking sensor associated with the weapon system goes into coast mode and remaining in this state longer than the **MAX-COAST-TIME** in the **SNR-TIME-DELAYS** data item,
- ◆ the element owning the tracking sensor being successfully attacked,
- ◆ the targeted location stopping movement or being destroyed, or an intercept being impossible.

first-player **ABORTED-INFLIGHT-SHOT-AT** second-player
firing time: <time>; wpn: <wpn-id> <wpn-type>

The game time at which the shot was aborted is given and the weapon involved is identified by its label and type.

ADDS-ENTRY-TO-JAMMER-QUEUE-FOR-TGT

For players that can reactively jam communications or sensors, this incident is the first of two decisions that must be made in this process. It defines when an entry can be added to the jammer queue and it signifies that an emitter is a candidate for having its frequency jammed. This entry will correspond to actions taken by the **JMR-QUEUE-ADD** procedure in **RESOURCE-ALLOCATION** tactics.

first-player **ADDS-ENTRY-TO-JAMMER-QUEUE-FOR-TGT** second-player
tgt emitter: <emtr-id> <emtr-type>; jammer: <jmr-id> <jmr-type>

The labels and the names of the targetted emitter and the jammer are listed.

ADDS-SUB-TO-ASGN-QUEUE-FOR-TGT

This records that a subordinate was added to the assignment queue for a particular target. This entry corresponds to actions taken by the **LETHAL-ASSIGNMENT-QUEUE-ADD** procedure in **RESOURCE-ALLOCATION** tactics.

first-player **ADDS-ENTRY-TO-ASGN-QUEUE-FOR-TGT** second-player

ADDS-WPN-TO-ENG-QUEUE-FOR-TGT

This records that a weapon was added to the engagement queue for the particular target. This entry corresponds to actions taken by the **LETHAL-ENGAGE-QUEUE-ADD** procedure in **RESOURCE-ALLOCATION** tactics.

first-player **ADDS-WPN-TO-ENG-QUEUE-FOR-TGT** second-player

ADJUSTS-JAMMER-SPOT-FOCUSED-AT

This records the action of adjusting the jammer spot to follow frequency changes made by a target emitter.

first-player **ADJUSTS-JAMMER-SPOT-FOCUSED-AT** second-player

Time History Data Items

```
target emitter: <emtr-id> <emtr-type>
old spot center <old-freq> MHz
new spot center <new-freq> MHz
```

It identifies the target emitter as well as the old and new frequencies.

BAFFLED-BY-ASG-CANCEL-FOR

A player has received an assignment cancellation on a target about which the player was unaware. This can occur when there is a backlog in communications.

```
first-player  BAFFLED-BY-ASG-CANCEL-FOR  second-player
```

, BY-COMMAND, -ENGAGES

This records the decision to begin a lethal engagement based on a prior lethal assignment.

```
first-player  , BY-COMMAND, -ENGAGES  second-player
with: <wpn-id> <wpn-name>;  tgt(x,y,z): <tgt-x> <tgt-y> <tgt-z> km;
hdg:  <heading> deg;      wpn(x,y,z): <wpn-x> <wpn-y> <wpn-z> km;
az:  <azimuth>  deg;      3-D dist: <distance> km;
```

The weapon's label and name are recorded along with both its and the target's positions. In addition the heading of the target and the azimuth of the range vector drawn from the weapon are given, both measured clockwise from due north. Finally the true distance between the target and the weapon is given.

CAN-CONTINUE-SALVO-AGAINST

Identifies the ability of a player to continue a salvo against a target after regaining lock. A player will discontinue salvoing if the tracker loses lock. If lock is regained before the maximum coast time is exceeded then the player will restart the salvoing sequence and record this message.

```
first-player  CAN-CONTINUE-SALVO-AGAINST  second-player
```

CANNOT-INTERCEPT

This message is recorded when ordnance fired by a weapon cannot intercept the target. This computation is based on the **WPN-SPD-CAPABILITY** of the ordnance and so is not relevant to weapons using future players. This message will be given on initial firing of the weapon or when manoeuvring of the target subsequent to the ordnance's launch make intercept impossible

```
first-player  CANNOT-INTERCEPT  second-player
at <game-time>
```

The message records the game time at which the computation was made.

CAN'T-MANEUVER-AGAINST

This message is recorded when a player is directed by its lethal engage tactics to engage a target but cannot manoeuvre to attack the target using reactive movement.

```
first-player  CAN'T-MANEUVER-AGAINST  second-player
reason: <reason-phrase>
current priority: <priority>
```


Time History Data Items

The item records the reasons for the problem, which will either be that the attack priority is not specified, or the target is not a member of the current attack priority, in which case the current priority will be printed out, or no plan name was specified for the mover to follow. Sometimes this message will be recorded when the scenario is behaving according to plan, for example when a plan does not come into play until a mover reaches a certain checkpoint in its path but can identify a target earlier.

CAN'T-USE-NEW-DETECTION-OF

Player has discarded a sensory perception of a target because its capacity to accept any more perceptions has been exceeded, this limit being specified by the **MAX-SNR-PERCEPTIONS** entry of the TDB.

first-player **CAN'T-USE-NEW-DETECTION-OF** second-player

CHANGES-TERRAIN-FOLLOWING-ALTITUDE

A player has altered its altitude at which it is currently flying above terrain. This event corresponds to a **NOW TERRAIN-FOLLOW-AT** item in the player's **MOVE-PLANS**.

first-player **CHANGES-TERRAIN-FOLLOWING-ALTITUDE**
new altitude: <altitude-value> m [original value]

The new altitude is recorded along with the phrase 'original value' when the height selected is that originally specified in the player's SDB.

CHANGE-IN-DETECTION-FOR

This event is recorded whenever a change has occurred in the sensing status of a particular target.

first-player **CHANGE-IN-DETECTION-STATUS-FOR** second-player
using <system-id> <sensor-receiver-name>
now <sensing status>
signature: <signature value> abs; at <az> degrees azimuth;
<el> degrees elevation; 3-D dist: <distance> km;
azimuth-to-tgt: <azimuth> deg;
elevation-to-tgt: <elevation> deg

A great deal of information is recorded for this event. First of the identification and name of the sensor receiver for which the change in status was recorded is noted along with a description of the status change. Nine possible status flags may change, although not all can occur for all sensors. These are recorded as follows:

Time History Data Items

Status Passed	Status Failed	Description
maximum doppler OK	doppler too high	Tests upper bound of sensor's doppler limits
minimum doppler OK	doppler too low	Tests lower bound of sensor's doppler limits
within elevation	outside elevation	Tests that the target is within the sensor's elevation limits
within azimuth	outside azimuth	Tests that the target is within the sensor's azimuth limits
signal/noise OK	signal/noise low	Tests that the target's signal is above the sensing threshold
above horizon	below horizon	Tests that the target is above the horizon
no terrain mask	terrain masking	Tests that the target is not hidden by terrain
within altitude	outside altitude	Tests that the target is within the altitude envelope of the sensor
within 2D-range	outside 2D-range	Tests that the target is within the range envelope of the sensor

The signature value is the computed radar, optical or infrared cross-section, or for radar warning receivers the emitted power minus its internal losses. The next two values record the current azimuth and elevation angles drawn from the target to the sensor. The cross-sections should correspond to the signature values defined in the target's susceptibility blocks so these angles are relative to the target's heading vector. The distance is the true three dimensional distance from the sensor to the target in kilometres. The azimuth to target is the azimuthal angle drawn from the sensor to the target measured clockwise from due north. The elevation to target is the vertical angle drawn from the sensor to the target with angles measured upwards from horizontal.

CHANGE-IN-SENSING-STATUS-FOR

This records when a sensor changes between failing to detect a target and successfully detecting a target. It is more selective than **CHANGE-IN-DETECTION-FOR** it is only recorded when the outcome of the sensing chance is changed by the event.

```

first-player CHANGE-IN-SENSING-STATUS-FOR second-player
using <system-id> <sensor-receiver-name> <success-phase>
sensor (x, y, z): <x> <y> <z> hdg: <h> deg;
target (x, y, z): <x> <y> <z> hdg: <h> deg;
[Target Phrase]
```

First of the identification and name of the sensor receiver for which the change is noted along with a description of whether the detection is succeeding, "now succeeding" or failing, "now failing". The Cartesian coordinates of the sensor and the target are both given, along with their headings measures in degrees clockwise from due north.

The 'Target Phrase' is recorded when the sensor is succeeding in detecting the target. For radars, optical sensors and infrared sensors it is:

Time History Data Items

tgt elements: <ele-id> <ele-name> ...

so listing the detected target element or elements. For radar warning receivers it is:

tgt transmitters: <xmit-id> <xmit-name> ...

listing the detected transmitters.

COASTING-BEYOND-PATH-END

This records that a reactive mover is continuing to move beyond the last point specified in its path while deciding what to do next.

first-player COASTING-BEYOND-PATH-END

plan name: <plan name>

The item records the name of the plan in effect at the time.

, COASTING, -STOPS-FIRING-AT

This shows that weapon firing has stopped during a salvo as a result of the tracking sensor going in coast mode.

first-player , COASTING, -STOPS-FIRING-AT second-player

CONFUSED-BY-ASG-STATUS-FROM

This records that a commander has received a status message from a subordinate regarding a target to which the subordinate has been assigned and about which the commander is currently unaware. This is a symptom of overloaded communication nets effecting the normal message transmissions between players. It implies that the subordinate did not receive an earlier message from the commander cancelling the assignment.

first-player CONFUSED-BY-ASG-STATUS-FROM second-player

CRASHES-INTO-THE-GROUND

A mover has crashed into the ground, as a result of a planned movement path or a reactive movement path. This event would normally not occur for ground vehicles.

first-player CRASHES-INTO-THE-GROUND second-player

CUES-HEADING-TOWARD-TARGET

This indicates that the heading of a player's location is being changed to point towards a target.

first-player CUES-HEADING-TOWARD-TARGET second-player

new heading: azimuth = <az> degrees from north,
elevation = <el> degrees

The new heading is given as an elevation angle and an azimuth measured clockwise from due north.

Time History Data Items

DECENTRALIZES-CONTROL-TO

This records a commander telling a subordinate to change its lethal mode of control value to its own player type. This event corresponds to actions taken by the commander's **LETHAL-ASSIGNMENT-START** tactics.

first-player **DECENTRALIZES-CONTROL-TO** second-player

DECIDES-TO-SHOOT-AT

This event records the decision to fire one round of ordnance at a target location.

first-player **DECIDES-TO-SHOOT-AT** second-player
 with: <wpn-id> <wpn-name>; tgt (x,y,z) <x> <y> <z> km;
 hdg: <heading> deg; wpn (x,y,z) <x> <y> <z> km;
 az: <azimuth> deg; 3-D dist: <distance> km; firing time <time>

The entry records the weapon's label and name, the Cartesian coordinates of the weapon and the target, the heading of the target and the azimuthal angle of the vector joining the weapon to the target measured clockwise from due north. In addition the three dimensional distance between the target and the weapon and the scheduled time of firing of the weapon in HH:MM:SS.s format are given.

DELETES-ASSIGNMENT-TO

When a commander decentralises control it will cancel all active assignments allowing the subordinates to decide what they want to do on their own.

first-player **DELETES-ASSIGNMENT-TO** second-player

DELETES-JAMMER-QUEUE-ENTRY-FROM-TGT

This records the action of removing a transmitter from a jammer's queue of candidate targets. This action corresponds to the **JAMMER-QUEUE-DROP** tactics in the TDB.

first-player **DELETES-JAMMER-QUEUE-ENTRY-FROM-TGT** second-player
 tgt emitter: <emtr-id> <emtr-type>; jammer: <jmr-id> <jmr-type>

The labels and types of the target transmitter and of the jammer are also recorded.

DEPARTS-ORBIT-FOR-A-PATTERN

This is recorded when reactive mover leaves an orbit specified by a repeating pattern and goes into another pattern, which might, or might not, be repeating..

first-player **DEPARTS-ORBIT-FOR-A-PATTERN** second-player

DID-NOT-CHANGE-ITS-PATH

After evaluating a plan in the player's **MOVE-PLANS** a reactive mover has not changed its path, but it might have changed its attack priorities or implemented another plan.

first-player **DID-NOT-CHANGE-ITS-PATH** second-player

Time History Data Items**DIGESTS-RESULTS-OF-ATTACK-ON**

A thinker with weapons has attacked and seen the results of the attack, it is now thinking about what to do next; it may disengage, continue to shoot, or reactively manoeuvre. If the target was killed a **SEES-DEATH-OF-KNOWN** message will be recorded following this.

first-player **DIGESTS-RESULTS-OF-ATTACK-ON** second-player

DISCONTINUES-MANEUVER

This event is recorded when a thinker has decided to stop manoeuvring towards a target for the purpose of lethal engagement.

first-player **DISCONTINUES-MANEUVER**

DISCONTINUES-TRACKING-OF

A player was tracking a target when it decided to stop the engagement. This will normally follow a **STOP-ENGAGEMENT** incident unless the tracking sensor which is also identified by label and name in the message was not locked onto the target.

first-player **DISCONTINUES-TRACKING-OF** second-player
with sensor: <snr-id> <snr-name>

DROPS-SUB-FROM-ASGN-QUEUE-FOR-TGT

A subordinate has been dropped from the assignment queue for a particular target location. This action corresponds to decisions made in the **LETHAL-ASSIGNMENT-QUEUE-DROP** tactics in the TDB.

first-player **DROPS-SUB-FROM-ASGN-QUEUE-FOR-TGT** second-player
subordinate: <player-id> <player-name>

The message also records the subordinate's label and name from the SDB.

DROPS-WPN-FROM-ENG-QUEUE-FOR-TGT

This records that a weapon has been dropped from the engagement queue for a particular target location. The action usually corresponds to decisions made in the **LETHAL-ENGAGE-QUEUE-DROP** tactics in the TDB.

first-player **DROPS-WPN-FROM-ENG-QUEUE-FOR-TGT** second-player
weapon: <wpn-id> <wpn-name>
[cause]

The weapon's identification label and name are also recorded, as well as the cause "due to loss of weapon system", of the event when it was *not* due to decisions made in the **LETHAL-ENGAGE-QUEUE-DROP** procedure. This occurs when the element containing the weapon system is lost by the player.

EMPLOYS-A-VERTICAL-PROFILE

This message is recorded when a thinker has chosen to use the named vertical profile, which is specified in its movement plans, to either attack or escape from a target. or to fly to or from a specified point.

first-player **EMPLOYS-A-VERTICAL-PROFILE**
profile name: <profile-name>

Time History Data Items

EXPECTS-TO-INTERCEPT

This records the time at which ordnance fired from a weapon is expected to intercept a target, with the estimated time being based upon the current trajectory of the target and the flyout capability of the weapon's ordnance. Several eventualities can cause the estimate to be wrong, including the target manoeuvring, the target being destroyed, or either the weapon being destroyed or the player losing track on the target when guiding the ordnance and so on.

```
first-player EXPECTS-TO-INTERCEPT second-player
at <game-time>
```

FAILS-<RESOURCE-ALLOCATION-PROCEDURE-NAME>

This occurs when a criterion in the named Resource-Allocation procedure evaluates to false and the decision maker, target, and resource match the user specifications in the MOD command **DEBUG**. (See the discussion in section 6.4 of the User Guide, 'Debugging Resource Allocation Procedures'.) There are seventeen different possible procedures and many more criteria that may fail for many different reasons which means that the possible output is very varied. For example for the **LETHAL-ENGAGE-FIRING-START** procedure we can have:

```
first-player FAILS-LETHAL-ENGAGE-FIRING-START
target: second-player
weapon: <wpn-id> <wpn-name>
criterion failed: <criterion-name>; filter: <filter-id>
current value/thresh: <current-value> <criterion-threshold>
```

The above message would be given when the test made by the named criterion, <criterion-name> in the given filter, <filter-id>, of the **LETHAL-ENGAGE-FIRING-START** procedure is a threshold criterion, e.g. **2D-DIST**, and is failing because the variable whose value is <current-value> is beyond the allowed threshold, <criterion-threshold>.

FINISHED-CHANGING-RADAR-FREQ

This message records that a player has completed the process of changing a radar's operating frequency to avoid jamming.

```
first-player FINISHED-CHANGING-RADAR-FREQ
system: <snr-id> <snr-name>; old frequency: <freq> GHz;
new frequency: <freq> GHz
```

The sensor transmitter name and label are recorded, along with its old and new operating frequencies.

FINISHED-RELOADING

This message records that the player has completed reloading a weapon system.

```
first-player FINISHED-RELOADING
weapon: <wpn-id> <wpn-name>;
ordnance: <ordnance-name>; quantity: <number>
```

Time History Data Items

The weapon's label, name along with the name and amount of ordnance reloaded are also given.

FIRES-A-WEAPON-AT

This message is recorded when a shot is fired at a target. An earlier **DECIDES-TO-SHOOOT-AT** incident must have occurred.

```
first-player FIRES-A-WEAPON-AT second-player
with: <wpn-id> <wpn-name>; <ammunition-type>
tgt-element: <tgt-id> <tgt-type> tgt(x,y,z): <x> <y> <z> km;
hdg: <heading> deg; wpn(x,y,z) <x> <y> <z> km;
az: <azimuth> deg; 3-D dist: <distance> km;
```

The entry records the weapon's label and name, along with the type of ammunition which is either the name of ordnance or of a future player. Following this are the label and name of the targetted element followed by the Cartesian coordinates of the target and the weapon, the heading of the target and the azimuthal angle of the vector joining the weapon to the target measured clockwise from due north. In addition the three dimensional distance between the target and the weapon is given.

FIRST-DIRECTLY-SEES

The player has perceived a target through its own sensor. A perception of the target could have existed prior to this, if it were based upon indirect intelligence.

```
first-player FIRST-DIRECTLY-SEES second-player
with sensor: <snr-id> <snr-name>; tgt(x,y,z): <x> <y> <z> km;
spd: <speed> m/s; hdg: <heading> deg; sense time: <game-time>
sensor(x, y, z): <x> <y> <z> km; 3-D dist: <distance> km
```

The label and name of the sensor receiver are specified, followed by the target's position, its speed and heading measured clockwise from due north. The time at which the target was sensed and the above information was accurate for is given followed by the sensor's current position and the distance between the sensor's current position and the perceived location of the target. (Remember that the target might have moved by the time this message is recorded.)

FIRST-HAS-SENSOR-IN-RANGE-OF

This records that a target is within the maximum range of the player's sensor for the first time.

```
first-player FIRST-HAS-SENSOR-IN-RANGE-OF second-player
using <snr-id> <snr-name>
sensor(x, y, z): <x> <y> <z> km; spd: <spd> m/s; hdg: <hdg> deg
target(x,y,z): <x> <y> <z> km; spd: <spd> m/s; hdg: <hdg> deg
2-D dist: <distance> km
bearing (snr-tgt): <bearing> deg
bearing (tgt-snr): <bearing> deg
```

The label and name of the relevant sensor are given along with the positions of the target and the sensor and the ground distance separating them. In addition when either the target or sensor are moving their speeds and headings are given, along with

Time History Data Items

the bearings from the moving players to the other. (The bearing is the ground angle between the range and velocity vectors.)

FIRST-INDIRECTLY-SEES

The player has perceived a target indirect intelligence received from another player.

```
first-player FIRST-INDIRECTLY-SEES second-player
from third-player
tgt(x,y,z): <x> <y> <z> km;  spd: <speed> m/s;
hdg: <heading> deg; time: <game-time>
```

The label and name of the player reporting the intelligence are specified, followed by the target's position, its speed and heading measured clockwise from due north. The time at which the target was physically sensed by the player that detected it is also recorded. The information pertaining to the target's position and velocity is of course only accurate at this time, and it might have changed by the time this message is recorded.)

FOCUSES-A-JAMMER-SPOT-ON-TGT

This message records that a decision has been made to reactively employ a jammer by focusing a spot on to some target frequency. The target frequency is the frequency of a detected emission by a communication or sensor transmitter.

```
first-player FOCUSES-A-JAMMER-SPOT-ON-TGT second-player
center freq: <frequency> MHz
tgt emitter: <emtr-id> <emtr-type>; jammer <jmr-id> <jmr-type>
```

The frequency of the spot plus the labels and names of the jammer and the targeted transmitter are given.

FOCUSES-A-PREEMPTIVE-JAMMER-SPOT

This lists any pre-emptive spots that are emitted when a jammer starts operation. These are specified in the SDB.

```
first-player FOCUSES-A-PREEMPTIVE-JAMMER-SPOT second-player
center freq: <frequency> MHz; <mod> modulation
jammer <jmr-id> <jmr-type>
```

The frequency and modulation of the spot plus the label and name of the jammer are given.

GETS-AN-ASSIGN-CANCEL-FOR

This records that a player has received a cancellation of an assignment to a target from its commander.

```
first-player GETS-AN-ASSIGN-CANCEL-FOR second-player
```

GETS-MODE-OF-CONTROL-CHANGE

This records that a player has received a change in its lethal mode of control from its commander.

```
first-player GETS-MODE-OF-CONTROL-CHANGE
```


Time History Data Items

due to a <type> order

The order for the change is either 'guns-free' or 'guns-tight' depending on whether the decision was made by the **GUNS-FREE** or **GUNS-TIGHT** tactical procedures respectively.

GIVES-UP-TRYING-TO-TALK-TO

A player has decided to stop trying to send a specific message to another player. The number of attempts is limited by a user's tactics instruction in the TDB. The inability to send the message can be due to equipment failure, faulty input data, low signal level, or the unrecognised death of a recipient.

first-player **GIVES-UP-TRYING-TO-TALK-TO** second-player
after <nth> attempt; re: <message-type>

The number of attempts to send the message and its type, one of: asg/eng status, wpn assignment, MOC change, cancel wpn asg, intelligence, death notice, move order or subordinate cuing.

HAD-A-BAD-LAUNCH-AGAINST

This records that a round of ordnance or the launcher has been lost. This occurs when a weapon was not fired even though it was scheduled to do so as recorded by a **DECIDES-TO-SHOOT-AT** message. Causes for this event include:

- ◆ the tracker starting to coast in between the decision to fire and the launch. The time in coast mode would have to exceed the maximum coast time of the tracker, or
- ◆ the target has been destroyed before the launch, or
- ◆ the tracker has been destroyed before the launch

first-player **HAD-A-BAD-LAUNCH-AGAINST** second-player
anticipated firing time: <time>; wpn <wpn-id> <wpn-name>

The scheduled firing time and the label and name of the weapon are given in this message.

HAS-LETHAL-ENGAGE-AUTHORITY

This message is recorded when a player has received a message giving it the authority to make lethal assignments or lethal engagements. That is, the player has received a lethal mode of control change.

first-player **HAS-LETHAL-ENGAGE-AUTHORITY**

HAS-LOST-CONTACT-WITH

A player has lost contact with the other player it was previously talking to. Jamming, masking or death could have broken the contact between the players.

first-player **HAS-LOST-CONTACT-WITH** second-player

Time History Data Items

HAS-NO-OPERATIONAL-SUBS

This message records that a commander has now no subordinates to whom lethal assignments can be made. All of its subordinates may be dead, or out of ammunition to use in engagements.

first-player HAS-NO-OPERATIONAL-SUBS

HEADS-HOME, -OUT-OF-ACTION

A reactive mover has decided to head home because it can no longer engage targets due to being out of ammunition.

first-player HEADS-HOME, -OUT-OF-ACTION

IGNORES-OLD-DETECTION-OF

A perception of a target has been discarded because it is out of date. This message originates in the noticing stage of the thinking process, when objects are transferred from short term to medium term memory by the thinker.

first-player IGNORES-OLD-DETECTION-OF second-player

IGNORES-OUTDATED-PLAN

As a result of a wakeup call, a reactive mover is scheduled to think about a plan. If something occurs prior to this call that causes the player to execute another plan then this incident identifies the plan that was to have been considered. The wakeup call will still occur, but a new plan will be considered.

first-player IGNORES-OUTDATED-PLAN

plan name: <plan-name>

, IN-ENVELOPE, -INTERCEPTS

This is recorded when a target has been intercepted by a weapon's round and the probability of kill is greater than 10^{-7} . This might or might not result in a hit since this probability is still quite small.

first-player , IN-ENVELOPE, -INTERCEPTS second-player

with <wpn-id> <wpn-name>;

tgt element: <tgt-id> <tgt-name> tgt (x,y,z): <x> <y> <z> km;

hdg: <hdg> deg; wpn (x,y,z): <x> <y> <z> km; az: <azimuth> deg;

3-D dist: <distance> km; P(k)-value;

launch-time: <time>

The information given includes the labels, names and positions of the weapon and of the target, as well as the speed and heading of the target. In addition the azimuth of the target from as seen from the weapon and the three dimensional distance of the target from the weapon are given. All this information is correct for the time of intercept. The time of launch of the round is also given along with the probability of kill. Note that all angles are measured clockwise from due north.

INITIATES-LOCKON-OF

This is recorded when a sensor has changed from trying to lock on to a target to locked on.

first-player INITIATES-LOCKON-OF second-player

with sensor: <snr-id> <snr-name>; tgt (x,y,z): <x> <y> <z> km;

Time History Data Items

hdg: <heading> deg; sensor(x, y, z): <x> <y> <z> km;
 az: <azimuth> deg; 3-D dist: <distance> km

The sensor used to lockon the target, as well as the both the target's and the sensor's position are given in addition to their separation, the heading of the target and the azimuthal angle of the target has seen from the sensor. Again all angles are measured clockwise from due north.

INITIATES-PERCEPTION-OF

A player has added a perception of a target to its list of perceptions for the first time.

first-player **INITIATES-PERCEPTION-OF** second-player

INTENDS-TO-INFORM

This records that a decision has been made to tell a commander or subordinate about a perceived player's location that has either been seen directly or indirectly by the current player. The message will not be recorded if there are messages pending which already carry this information.

first-player **INTENDS-TO-INFORM** second-player

INTENDS-TO-USE-LAST-ROUND-ON

If a player determines that is about to use last round in its next salvo then it will inform its commander of the fact, and this event will be recorded by this message.

first-player **INTENDS-TO-USE-LAST-ROUND-ON** second-player

IS-ASSIGNED

This event records the fact that a player has received a lethal assignment message and has begun to act upon it.

first-player **IS-ASSIGNED** second-player <number of assignments>

When the current assignment is the player's only assignment it will record the comment 'as its only assignment', otherwise the number of assignments will be recorded.

IS-BACKED-UP, -TRIES-TO-TELL

This item appears when a communication net is backlogged. It records that a previous message containing intelligence about the target is already awaiting transmission to the same recipient.

first-player **IS-BACKED-UP, -TRIES-TO-TELL** second-player
 about third-player

IS-JAMMED- (EXPLICITLY) -WHILE-SENSING

This item occurs when a sensing chance fails whilst a radar is being jammed. The signal, noise and jamming noise values along with the minimum signal sensing threshold are all given.

first-player **IS-JAMMED- (EXPLICITLY) -WHILE-SENSING** second-player
 sensor: <snr-id> <snr-name>; signal power: <signal> watts;
 total noise from <noise or pulse> jammer(s): <noise> watts;
 total noise from all sources: <noise> watts;

Time History Data Items

signal-to-noise threshold: <threshold> dB; <sensing> absolute.

The label and name of the jammed radar receiver is shown and the total noise from all sources is given when the predominant jamming noise originates from noise jammers.

IS-RETURNING-TO-SDB-PLANNED-PATH

This records that a mover is returning to its planned SDB path.

first-player IS-RETURNING-TO-SDB-PLANNED-PATH

IS-TRANSMITTING-MESSAGE-TO

This records that a message is just commencing transmission. The net will be busy for the time it takes the message to be transmitted as determined by user instructions in the SDB.

first-player IS-TRANSMITTING-MESSAGE-TO second-player
re: <message-type>,
using net (ID) <net-id> at <net-frequency> MHz;
<message-phrase>

The message type is describes the nature of the message, e.g. wpn assignment, and the net's numerical label from the SDB and its current operating frequency are given. If the net is implicit the message phrase is always 'fine', since these nets are immune to signal loss or jamming. With explicit nets the signal strength, the interfering signal strength from combined noise and jamming sources and the message quality, either 'good' or 'bad' is recorded:

signal level: <signal-strength> dB;
interference: <interference-strength> dB;
message-quality <quality>

LEAVES-A-WAKEUP-CALL

A reactive mover has scheduled an alarm call to schedule the evaluation of its move plans. There is no control over which is evaluated, since there is no way of knowing which plan is going to be executed at the nominated time.

first-player LEAVES-A-WAKEUP-CALL
at <time>

The item records the time at which the wakeup call has been scheduled for.

LEAVES-AN-ORBIT-FOR-A-POINT

This records that a reactive mover has decided to leave an orbit specified by a repeating pattern in its movement plans and go to a point.

first-player LEAVES-AN-ORBIT-FOR-A-POINT

LOCKON-SIGNAL-LOSS-FROM

This occurs when a tracking sensor has lost lock on a target. The signal loss could be due to many causes, as indicated by the CHANGES-IN-DETECTION-FOR incident.

first-player LOCKON-SIGNAL-LOSS-FROM second-player
with <sensor-id> <sensor-name>

Time History Data Items

The name and label of the sensor which has lost lock are given.

LOST-LAST-SUB-TO-ATTACK

A commander has realised that it has no more subordinates, since its last one was destroyed.

first-player **LOST-LAST-SUB-TO-ATTACK**

MANEUVERS-IN-RESPONSE-TO

This records the fact that a manoeuvring player considers a target engageable, but that its current movement plan instructs it to move somewhere else. This might occur when a player is taking evasive action to avoid a threat.

first-player **MANEUVERS-IN-RESPONSE-TO** second-player
tgt(x, y): <x> <y> km; spd: <speed> m/s; hdg: <hdg> deg;
weapon(x, y): <x> <y> km; spd: <speed> m/s; hdg: <hdg> deg

The position, and when it is moving, the speed and heading of the target are given, as well as the position, speed and heading of the mover. The label 'weapon' is given because the mover has allocated a weapon to the target in its **LETHAL-ENGAGE-QUEUE-ADD** tactics.

MANEUVERS-TO-ATTACK

This is recorded when a player intends to move towards target with the intention of engaging it. Events considered both in the **MOVE-PLANS** and the **LETHAL-ENGAGE** tactics will be relevant to this item.

first-player **MANEUVERS-TO-ATTACK** second-player
tgt(x, y): <x> <y> km; spd: <speed> m/s; hdg: <hdg> deg;
intercept (x,y): <x> <y> km;
weapon(x, y): <x> <y> km; spd: <speed> m/s; hdg: <hdg> deg

The position, and when it is moving, the speed and heading of the target are given, as well as the projected position of the intercept point and the position, speed and heading of the mover. The label 'weapon' is given because the mover has allocated a weapon to the target in its **LETHAL-ENGAGE-QUEUE-ADD** tactics.

MANEUVERS-TO-PLAN-ASPECT-ANGLE

This is recorded when a mover is heading towards a point using a route specified in a **PLAN-ASPECT** table.

first-player **MANEUVERS-TO-PLAN-ASPECT-ANGLE**
aspect type: <name> desired aspect angle: <angle> <dir> deg;
dist: <dist> km; desired (x,y,z): <x> <y> <z> km;
current (x,y,z): <x> <y> <z> km

The extra information given with this incident is the name of the **PLAN-ASPECT** table being followed, the current angle between the mover and the target point from the table along with the label **LEFT** or **RIGHT** indicating its sense, the position of the desired point and its distance from the current position which is also given.

Time History Data Items

MOURNS-DEATH-OF

Signifies the realization by a commander that a subordinate has died, or by a subordinate that a commander has died. Death can mean either that the player was destroyed by an attack or that has completed its movement plans.

first-player MOURNS-DEATH-OF second-player

,NET-BUSY, -WANTS-TO-TALK-TO

This records the fact that a player has attempted to send message to another player on a given net, but the message transmission will be delayed because the net is busy. When the net is free the message will be transmitted.

first-player ,NET-BUSY, -WANTS-TO-TALK-TO second-player
re: <message-type>
<Reason for Delay>

The message type describes the contents of the message, e.g. intelligence. The reason for the delay is given; if the delay is due to another message currently being sent this will be:

one message currently being transmitted.

If in addition other messages are awaiting transmission several other lines of information will also be given, each summarizing the number of messages of a particular type awaiting transmission. e.g.:

4 wpn assignment message(s) pending
1 intelligence message(s) pending
one message currently being transmitted.

,NET-FREE, -WANTS-TO-TALK-TO

This records the fact that a player has attempted to send message to another player on a free net.

first-player ,NET-FREE, -WANTS-TO-TALK-TO second-player
re: <message-type>

The message type describes the contents of the message, e.g. death notice.

NO-LONGER-PERCEIVES

This item is recorded when a perception has been discarded from medium term memory by the current player. This can occur due to the following reasons:

- ◆ the time lapse since the last update exceed the TIME-BEFORE-DROP data item in the TDB,
- ◆ the perceived location is known to have been destroyed, or
- ◆ the player having the perception was killed or stopped movement.

first-player NO-LONGER-PERCEIVES second-player
last sensed at: <time>

The last time that the perceived player was directly sensed is recorded with this item.

Time History Data Items

,NOT-IN-ENVELOPE, -INTERCEPTS

This is recorded when a target has been intercepted by a weapon's round and the probability of kill is smaller than 10^{-7} . This might or might not result in a hit even though this probability is quite small!

```
first-player ,NOT-IN-ENVELOPE, -INTERCEPTS second-player
with <wpn-id> <wpn-name>;
tgt element: <tgt-id> <tgt-name>  tgt (x,y,z): <x> <y> <z> km;
hdg: <hdg> deg; wpn (x,y,z): <x> <y> <z> km; az: <azimuth> deg;
3-D dist: <distance> km; P(k)-value;
launch-time: <time>
```

The information given includes the labels, names and positions of the weapon and of the target, as well as the speed and heading of the target. In addition the azimuth of the target from as seen from the weapon and the three dimensional distance of the target from the weapon are given. All this information is correct for the time of intercept. The time of launch of the round is also given along with the probability of kill. Note that all angles are measured clockwise from due north.

NOW-SENSING-ELEMENTS-OF-TGT

This records which elements of a target are detected during a single sensing event. The obtained information has not been mentally processed so is in the player's short term memory.

```
first-player NOW-SENSING-ELEMENTS-OF-TGT second-player
<signature-phrase>
at <az> degrees azimuth; <el> degrees elevation;
with sensor: <snr-id> <snr-name>
elements: [Element phrase] ...
          and others....
```

The item records the details of the target's signature, which is one of:

```
radar cross section: <sig> square meters
optical cross section: <sig> square meters
ir-radiance: <rad> watts per steradian,  optical cross section:
<sig> square meters
emitter power: <pwr> dB, emitter antenna gain: <gain> dB
```

depending on whether the sensor is a radar, optical, infrared or radar warning receiver respectively. These are followed by the azimuth and elevation angles from the target to the sensor used to look up these signature values. These angles should be referred to the target's heading. Finally the sensor is identified with up to ten detected target elements by labels and names. If more than ten elements were detected the phrase 'and others...' is included.

,ON-ITS-OWN, -ENGAGES

This event is recorded when a player decided on its own to start a lethal engagement sequence.

```
first-player ,ON-ITS-OWN, -ENGAGES second-player
with: <wpn-id> <wpn-name>; tgt(x,y,z): <x> <y> <z> km;
hdg: <heading> deg; wpn(x,y,z) <x> <y> <z> km;
az: <azimuth> deg; 3-D dist: <distance> km;
```

Time History Data Items

The entry records the weapon's label and name. Following this are the label and name of the targetted element followed by the Cartesian coordinates of the target and the weapon, the heading of the target and the azimuth of the target as seen from the weapon. In addition the three dimensional distance between the target and the weapon is given.

PICKS, -FOR-LETHAL-ASG, -SUB

This item records that a commander intends to send a lethal assignment message to a subordinate.

```
first-player PICKS, -FOR-LETHAL-ASG, -SUB second-player
  for third-player
    tgt(x, y): <x> <y> km; hdg: <hdg> deg;
    sub(x, y): <x> <y> km; hdg: <hdg> deg
    az: <azimuth> deg; 3-D dist: <distance> km;
```

The position and heading of both the target and subordinate are listed along with the azimuth of the target as seen from the subordinate. In addition the three dimensional distance between the target and the subordinate is given.

POSSIBLY-MIGHT-CRASH-LATER

This records that a reactively manoeuvring player might crash into the ground if it maintains its current path.

```
first-player POSSIBLY-MIGHT-CRASH-LATER
  at <time>
```

The time at which the crash is predicted is printed out with this message.

RANDOMLY-LOSES-LOCK-ON

This message is recorded when a tracking sensor has randomly lost lock on to the target during an engagement.

```
first-player RANDOMLY-LOSES-LOCK-ON second-player
  with <sensor-id> <sensor-name>
```

The name and label of the sensor involved in the event is recorded.

REACHES-CHECKPOINT

This message is recorded when a mover has reached checkpoint identified in the SDB.

```
first-player REACHES-CHECKPOINT
  checkpoint name: <checkpoint-name>
```

The name of the checkpoint is included in the output.

REMOVES-A-JAMMER-SPOT-FROM-TGT

This message corresponds to a player deciding to cease nonlethal engagement of a target based on its JAMMER-SPOT-DROP tactics in the TDB.

```
first-player REMOVES-A-JAMMER-SPOT-FROM-TGT second-player
```


Time History Data Items

center freq: <frequency> MHz
 tgt emitter: <emtr-id> <emtr-type>; jammer <jmr-id> <jmr-type>

The frequency of the spot plus the labels and names of the jammer and the targetted transmitter are given.

RESETS-CUING-TO-DEFAULT

This incident refers to a player's heading being redirected to point in its initial direction, which corresponds to a **WITH-SDB-CUING-FOR-LOC** action in the player's tactics.

first-player **RESETS-CUING-TO-DEFAULT**
 new heading: azimuth = <az> degrees from north,
 elevation = <el> degrees

The new heading in terms of its azimuth and elevation of the player's location is indicated.

RESUMES-MOVEMENT

This shows that a player has resumed movement after it has being suspended.

first-player **RESUMES-MOVEMENT**
 mover (x,y,z): <x> <y> <z> km

The position of the mover when it resumed movement is given.

RUNS-OUT-OF-GAS

This is recorded when a player has stopped moving because it has run out of fuel. The player is removed from the scenario.

first-player **RUNS-OUT-OF-GAS**

SCRAMBLES-TO-ORBIT

This records that a player has decided to start moving as a result of receiving a movement order.

first-player **SCRAMBLES-TO-ORBIT**

SEES-DEATH-OF-KNOWN

This records that a player has directly sensed and assimilated the information regarding the death of a player. For this to occur the player must have known about the player and be sensing the player at the time of its death.

first-player **SEES-DEATH-OF-KNOWN** second-player

SELF-DESTRUCTS-IN-FAILURE

A reactive mover was trying to attack a target, missed it, and in the process managed to blow itself up. It did not damage the target.

first-player **SELF-DESTRUCTS-IN-FAILURE**

Time History Data Items

SENDS-ASSIGN-CANCEL-TO

This documents a commander cancelling a lethal engagement and informing the subordinate.

first-player **SENDS-ASSIGN-CANCEL-TO** second-player

SENDS-DEATH-NOTICE-TO

This records that a player intends to tell another player about the death of a third party.

first-player **SENDS-DEATH-NOTICE-TO** second-player
about third-player

SENDS-SCRAMBLE-TO

This item records the decision to send a movement order to a subordinate. The subordinate will either implement it or send it along to another subordinate. This item corresponds to the **LAUNCH-START** tactics of the commander.

first-player **SENDS-SCRAMBLE-TO** second-player

SHOT-SPENT, -UNAWARE-OF-DEATH-OF

This records an occasion where ordnance has been fired at a target that has already been destroyed.

first-player **SHOT-SPENT, -UNAWARE-OF-DEATH-OF** second-player
firing time: <time>

The time at which the shot was fired is also recorded.

STARTING-TO-CHANGE-NET-FREQ

This occurs when a player has decided to change the frequency of communication transmissions on a net due to the detected presence of jamming or of terrain masking. If the cause was terrain masking changing frequency won't help the player much.

first-player **STARTING-TO-CHANGE-NET-FREQ**
current frequency: <freq> MHz;
new net frequency: <freq> MHz;
busy until time <time>

The old and new net frequencies are given, along with the projected earliest time at which the message could have been sent.

STARTING-TO-CHANGE-RADAR-FREQ

This item is recorded when a player has decided to change the frequency for a radar transmitter in order to evade the jamming that the radar operator has detected.

first-player **STARTING-TO-CHANGE-RADAR-FREQ**
system: <sys-id> <sys-name>; current frequency: <freq> GHz;
new frequency: <freq> GHz;
finished at time: <time>

The name and label of the radar transmitter involved, along with its current and new frequencies and the time at which the frequency change is expected to be completed are recorded.

Time History Data Items

STARTING-TO-RELOAD

This shows that a player has started to reload a weapon system.

```
first-player STARTING-TO-RELOAD
weapon name: <wpn-id> <wpn-name>
```

The weapon's label and name are given in this item.

STARTS-MOVEMENT

This indicates that a player has begun movement.

```
first-player STARTS-MOVEMENT
```

STARTS-TO-EXECUTE-A-PLAN

When a player is going to start executing one of its movement plans this item will be recorded.

```
first-player STARTS-TO-EXECUTE-A-PLAN
plan name: <plan-name>
```

The plan is identified in the output.

STARTS-TO-HEAD-TOWARDS-CHECKPOINT

This shows that a mover is beginning to head towards a checkpoint using a GOTO POINT command in a movement plan.

```
first-player STARTS-TO-HEAD-TOWARDS-CHECKPOINT
checkpoint name: <checkpoint-name>
```

The name of the checkpoint that the mover is heading towards is indicated in the output of this item.

STARTS-TO-USE-PREDICTED-INTERCEPT-MODE

This documents when a player has changed its intercept mode to PREDICTED.

```
first-player STARTS-TO-USE-PREDICTED-INTERCEPT-MODE
```

STARTS-TO-USE-PURSUIT-INTERCEPT-MODE

This records when a player has changed its intercept mode to PURSUIT.

```
first-player STARTS-TO-USE-PURSUIT-INTERCEPT-MODE
offset from target: <offset> m
```

The offset from the target is recorded. If this is a positive value the player is chasing a point in advance of the target, when it is negative it pursues a point which lags behind the target.

STOPS-ENGAGEMENT-OF

This incident occurs and is recorded at the end of a lethal engagement. Usually this is because of a decision made by the attacking player using its LETHAL-ENGAGE-STOP tactics. Some other reasons are:

- ◆ the attacker was told to stop the engagement by its commander,

Time History Data Items

- ◆ the attacker perceived that the target has died,
- ◆ the attacker has no more rounds to fire,
- ◆ the attacker has perceived that the target no longer meets hostile criteria, or
- ◆ the attacker's tracking sensor and or weapon have been destroyed.

first-player **STOPS-ENGAGEMENT-OF** second-player
with <wpn-id> <wpn-name>

The label and name of the weapon that was being used to engage the target are recorded.

STOPS-MOVEMENT

This shows that a mover has come to the end of its movement path and there are no more entries on the future path list or it has run out of fuel. The mover will be treated as if it had been destroyed.

first-player **STOPS-MOVEMENT**
mover (x,y,z): <x> <y> <z> km; spd: <speed> m/s;
hdg: <heading> deg; pitch: <pitch> deg

The position, speed, heading and pitch angle of the mover at the time it ceased to move are recorded. The pitch angle is the vertical angle between the mover's velocity vector and the horizontal plane. So straight up is +90°, straight down is -90° and horizontal is 0°.

STOPS-SENSING-CHANCES-FOR

This occurs when a player has stopped sensing a target with a particular sensor. The sensor may have been turned off or the target may have gone out of the sensor's range. The player may still be able to see the target with other sensors.

first-player **STOPS-SENSING-CHANCES-FOR** second-player
regarding the <system-id> <sensor-name>

The label and name of the relevant sensor are recorded.

STOPS-TERRAIN-FOLLOWING

This records when a player has stopped terrain following by executing a **NOW STOP TERRAIN-FOLLOW** instruction in a move plan.

first-player **STOPS-TERRAIN-FOLLOWING**

SUCCESSFULLY-HIT

This event is recorded when a target has been successfully hit by the attacking player and has sustained some degree of damage or disability.

first-player **SUCCESSFULLY-HIT** second-player
tgt element: <tgt-id> <tgt-name>
Applied Pk: <pk>
Weapon Pk: <wpn pk>
Pk Degrade Factor: <pk degrade>
[Result Phrase]
[Critical Phrase]

Time History Data Items

The label and the name of the targetted element are listed, along with the probability of kill for this incident drawn from the **WPN-PK** and the **WEAPON-PK-DEGRADE** tables in the TDB. If the randomly selected 'Applied Pk' is less than the appropriate Pk value then the target will be damaged or destroyed, which is always true for this incident to be recorded. When damaged the degree of damage is recorded in the 'Result Phrase' and depends upon whether or not the element has a **DISCRETE** or **CONTINUOUS** nature. If it is discrete the surviving quantity of this element is decremented by one. If this value is not reduced to zero by this the result is 'element hurt'. If the value is reduced to zero but other elements at the location survive the result is 'element destroyed'. If no other elements survive at the current location, or the element is critical to the location's survival, the result is 'location destroyed' if other locations survive. If the whole player is killed then the phrase 'player destroyed' is recorded.

If the element has a **CONTINUOUS** nature it cannot be completely destroyed. Instead the cumulative probability of survival is reduced according to the accumulated probability of kill.

SUSPENDS-MOVEMENT

This shows when a player has suspended movement.

```
first-player SUSPENDS-MOVEMENT
mover (x,y,z): <x> <y> <z> km; Spd: <speed> m/s;
hdg: <heading> deg; Pitch: <pitch> deg
```

The position, speed, heading and pitch angle of the mover at the time it suspended movement are recorded.

TERRIBLY-PUZZLED-BY-MSG-FROM

This is recorded when a commander receives a message about a target to which a subordinate has been assigned which is by now on neither of the commander's or the subordinate's perception lists. This can occur when communication nets are overloaded delaying transmission between players.

```
first-player TERRIBLY-PUZZLED-BY-MSG-FROM second-player
```

TOLD-ABOUT-DEAD

This shows that information has been received and assimilated about the death of a target that was assigned to the player that sent the message. In reaction to this information the player may:

- inform its commander,
- delete a perception of the target
- cancel assignments on that target.

```
first-player TOLD-ABOUT-DEAD second-player
by third-player
```

Time History Data Items

TOLD-OF-DEATH-OF-KNOWN

This records that Information has been received and assimilated about the destruction of a location about which the subject has knowledge (directly or indirectly) via a sensor. In reaction to this information the player may:

- delete a perception of the target
 - inform another player,
 - cancel assignments on that target.
- first-player TOLD-OF-DEATH-OF-KNOWN second-player
by third-player

TOLD-OF-NO-AMMO-BY

This item is recorded when a commander has received and assimilated a message from a subordinate telling it that the subordinate will have no ammunition after firing its next salvo.

first-player TOLD-OF-NO-AMMO-BY second-player

URNS-OFF-COMM-TRANSMITTER

This occurs when a player has turned off a named communication transmitter. This can be a planned event or occur when the transmitter is destroyed.

first-player TURNS-OFF-COMM-TRANSMITTER
namely the <system-id> <system-name>

URNS-OFF-IMPLICIT-JAMMER

This occurs when a player has turned off a named implicit jammer. This can be a planned event or occur when the jammer is destroyed or be due to non-lethal engagement tactics.

first-player TURNS-OFF-IMPLICIT-JAMMER
namely the <system-id> <system-name>

URNS-OFF-JAMMER-TRANSMITTER

This occurs when a player has turned off a named explicit jammer. This can be a planned event or occur when the jammer is destroyed or be due to non-lethal engagement tactics.

first-player TURNS-OFF-JAMMER-TRANSMITTER
namely the <system-id> <system-name>

URNS-OFF-SENSOR-RECEIVER

This occurs when a player has turned off a named sensor receiver. This can be a planned event, or occur under the control of emission control tactics or occur when the receiver is destroyed.

first-player TURNS-OFF-SENSOR-RECEIVER
namely the <system-id> <system-name>
[EMCON Phrase]

When the sensor receiver was turned off due to EMCON/TURN-OFF tactics the phrase 'as a result of emission control' is printed out. Turning off the linked sensor transmitter will turn off the sensor receiver.

Time History Data Items**URNS-OFF-SENSOR-TRANSMITTER**

This occurs when a player has turned off a named sensor transmitter. This can be a planned event, or occur under the control of emission control tactics or occur when the transmitter is destroyed.

first-player **URNS-OFF-SENSOR-TRANSMITTER**
 namely the <system-id> <system-name>
 [EMCON Phrase]

When the sensor transmitter was turned off due to **EMCON/TURN-OFF** tactics the phrase 'as a result of emission control' is printed out. Turning off the sensor transmitter will turn off the linked sensor receiver.

URNS-ON-COMM-TRANSMITTER

This occurs when a player has turned on a named communication transmitter. This occurs due to a planned event in the SDB.

first-player **URNS-ON-COMM-TRANSMITTER**
 namely the <system-id> <system-name>

URNS-ON-IMPLICIT-JAMMER

This occurs when a player has turned on a named implicit jammer. This can be a planned event or occur due to non-lethal engagement tactics.

first-player **URNS-ON-IMPLICIT-JAMMER**
 namely the <system-id> <system-name>

URNS-ON-JAMMER-TRANSMITTER

This occurs when a player has turned on a named explicit jammer. This can be a planned event or occur due to non-lethal engagement tactics.

first-player **URNS-ON-JAMMER-TRANSMITTER**
 namely the <system-id> <system-name>

URNS-ON-SENSOR-RECEIVER

This occurs when a player has turned on a named sensor receiver. This can be a planned event or occur under the control of emission control tactics.

first-player **URNS-ON-SENSOR-RECEIVER**
 namely the <system-id> <system-name>
 [EMCON Phrase]

When the sensor receiver was turned on due to **EMCON/TURN-ON** tactics the phrase 'as a result of emission control' is printed out.

URNS-ON-SENSOR-TRANSMITTER

This occurs when a player has turned on a named sensor transmitter. This can be a planned event or occur under the control of emission control tactics.

first-player **URNS-ON-SENSOR-TRANSMITTER**
 namely the <system-id> <system-name>
 [EMCON Phrase]

Time History Data Items

When the sensor transmitter was turned on due to **EMCON/TURN-ON** tactics the phrase 'as a result of emission control' is printed out

UNFORTUNATELY-MISSED

This is recorded when a attacking player missed a its target with the selected weapon. The miss is not unfortunate for the target.

```
first-player UNFORTUNATELY-MISSED second-player
tgt element: <tgt-id> <tgt-name>
Applied Pk: <pk>
Weapon Pk: <wpn pk>
Pk Degrade Factor: <pk degrade>
```

The label and the name of the targetted element are listed, along with the probability of kill for this incident drawn from the **WPN-PK** and the **WEAPON-PK-DEGRADE** tables in the TDB. If the randomly selected 'Applied Pk' is greater than the appropriate Pk value then the target has been missed, , which is always true for this incident to be recorded.

UPDATES-INTERACTIONS

This shows that the player has moved across an internally represented boundary describing the mover's position and it is now going to check to see if there are any sensing chances that should be corrected. (Because the mover is in a new position its physical environment and distance to all other players will have changed, thereby effecting the sensing chances with these entities).

```
first-player UPDATES-INTERACTIONS
(x,y,z): <x> <y> <z> km;
spd: <speed> m/s; hdg: <heading> deg;
attitude: <attitude> deg
```

The mover's position, speed and heading are all given, along with the mover's attitude. This is also referred to as the pitch of the mover in other entries.

UPDATES- (W/MSG) -DATA-ON

This records the player's reception and assimilation of information contained in a message.

```
first-player UPDATES- (W/MSG) -DATA-ON second-player
from third-player
tgt(x,y,z): <x> <y> <z> km; spd: <speed> m/s;
hdg: <heading> deg; time: <time>
```

The target's position, speed and heading at the time of the sensory perception upon which this messages information was based are given, along with this time.

UPDATES- (W/SNR) -DATA-ON

This records the player's recognition and assimilation of information contained in a sensing chance

```
first-player UPDATES- (W/SNR) -DATA-ON second-player
with sensor: <snr-id> <snr-name>; tgt(x,y,z): <x> <y> <z> km;
```


Time History Data Items

spd: <speed> m/s; hdg: <heading> deg; sense time: <time>;
 sensor(x,y,z): <x> <y> <z> km; 3-D dist: <distance> km

The name and position of the sensor is specified. Following this are the target's position, speed and heading at the time of the sensory perception, along with this time and the separation between the sensor and the target at this moment.

USING-TRACKER-FOR-ACQ-ALSO

This signifies that a player is using a tracking sensor to perform acquisition functions. This can occur when a player has lost all its acquisition sensors and so expands the capabilities of a tracking sensor.

first-player USING-TRACKER-FOR-ACQ-ALSO

WAKES-UP-TO-THINK-ABOUT-PLAN

This records that a player has received a wakeup call scheduled previously. The player may execute the plan or ignore the plan if it is irrelevant.

first-player WAKES-UP-TO-THINK-ABOUT-PLAN
 plan name: <plan-name>

The name of the plan in question is recorded in this item.

WANTS-TO-TELL-NEW-STATUS-TO

This item is recorded when a player intends to inform it's commander about the status of an ongoing engagement.

first-player WANTS-TO-TELL-NEW-STATUS-TO second-player
 status is: <status>

The status that is reported is one of the following:

not acquired/out of date	begins engagement	out of ammo/non-op
operational	commences firing	killed target

WILL-BE-OUT-OF-RANGE-OF

This shows that the target is leaving a sensor's detection range.

first-player WILL-BE-OUT-OF-RANGE-OF second-player
 at time: <time>; sensor: <snr-id> <snr-name>

The time specified is that of the next sensing chance, at which point it is anticipated that the target will be out of range of the named sensor receiver.

WILL-NOT-STOP, -IN-ORBIT

This shows that a player location has come to the end of a repeating pattern but will continue to orbit in this pattern.

first-player WILL-NOT-STOP, -IN-ORBIT

WILL-START-PATTERN-MOVEMENT

This item is recorded when a reactive mover will start a repeating or non-repeating pattern.

first-player WILL-START-PATTERN-MOVEMENT

Time History Data Items

pattern-name: <pattern-name>; at later time <time>

The name of the pattern from the player's **PLAN-PATTERN** table in the TDB plus the time at which it is expected that the pattern will be begun are printed out.

WILL-THINK-OF-PRESET-PLAN

This indicates that a player will soon consider a plan defined both in the player's TDB and SDB.

first-player **WILL-THINK-OF-PRESET-PLAN**
plan-name: <plan-name>; at later time <time>

The name of the pattern from the player's **MOVE-PLANS** in the TDB and its **PATH** statement in the SDB plus the time at which it is expected that the plan will be commenced are recorded..

WILL-TRY-AGAIN-TO-TALK-TO

This item occurs when a player decides to try and send a message that has already on one or more occasions failed to get through. This message may be generated when errors in then SDB file have resulted in the players being on different communication nets or attempting to use different frequencies. Alternatively it may be caused by jamming, terrain masking, the death of a player or the destruction of equipment.

first-player **WILL-TRY-AGAIN-TO-TALK-TO** second-player
for the <nth> time, re: <message-type>

The number of attempts that the message will have been attempted is shown along with the message's type, e.g. move order.

WON'T-USE-OLD-LOCATION-DATA-FOR-TGT

This occurs when a player has thrown out possible perception location data because it is out of date. Notice it is only the data relating to the target's position that are disregarded, not items pertaining to more persistent qualities such as its type, IFF status and so on.

first-player **WON'T-USE-OLD-LOCATION-DATA-FOR-TGT** second-player
<from phrase>

If the old data stem from intelligence then the 'from phrase' is the player which sent the message, if they stem from a sensor the phrase identifies the sensor receiver.

YEARNs-TO-SEND-ASG-UPDATE-TO

This shows that a player wants to inform its commander about the status of a target to which it has been assigned.

first-player **YEARNs-TO-SEND-ASG-UPDATE-TO** second-player
status is: <status>

Time History Data Items

The status that is reported is one of the following:

not acquired/out of date
operational

begins engagement
commences firing

out of ammo/non-op
killed target

DISTRIBUTION LIST

A Programmer's Reference to the Suppressor Simulation System

Robert Whitehurst, Victor Kowalenko and Jane Phipps

AUSTRALIA

DEFENCE ORGANISATION

S&T Program

Chief Defence Scientist	}	
FAS Science Policy	}	shared copy
AS Science Corporate Management	}	
Director General Science Policy Development		
Counsellor Defence Science, London (Doc Data Sheet)		
Counsellor Defence Science, Washington (Doc Data Sheet)		
Scientific Adviser to MRDC Thailand (Doc Data Sheet)		
Director General Scientific Advisers and Trials/Scientific Adviser Policy and		
Command (shared copy)		
Navy Scientific Adviser		
Scientific Adviser - Army		
Air Force Scientific Adviser		
Director Trials		

Aeronautical and Maritime Research Laboratory

Director

Electronics and Surveillance Research Laboratory

Director

Chief of Air Operations Division
Neil Pollock, AOD
Robert Dancer, AOD
Simon Goss, AOD
Graeme Murray, AOD
Gary Kemister, AOD
Serena Steuart, AOD
Helen Pongracic, AOD
Robert Whitehurst, AOD
Victor Kowalenko, School of Physics, University of Melbourne
Jane Phipps, AOD
Ken Anderson, TOG, Melbourne
Russell Pope, EWD
Nick Hadjinicolaou, EWD
Leigh Powis, MRD
Shane Brunker, EWD

DSTO Library

Library Fishermens Bend
Library Maribyrnong
Library DSTOS (2 copies)
Australian Archives
Library, MOD, Pyrmont (Doc Data sheet only)

Forces Executive

Director General Force Development (Sea)
Director General Force Development (Land)

Army

ABCA Office, G-1-34, Russell Offices, Canberra (4 copies)

S&I Program

Defence Intelligence Organisation
Library, Defence Signals Directorate (Doc Data Sheet only)

B&M Program (libraries)

OIC TRS, Defence Central Library
Officer in Charge, Document Exchange Centre (DEC), 1 copy
*US Defence Technical Information Centre, 2 copies
*UK Defence Research Information Center, 2 copies
*Canada Defence Scientific Information Service, 1 copy
*NZ Defence Information Centre, 1 copy
National Library of Australia, 1 copy

UNIVERSITIES AND COLLEGES

Australian Defence Force Academy
Library
Head of Aerospace and Mechanical Engineering
Senior Librarian, Hargrave Library, Monash University
Librarian, Flinders University

OTHER ORGANISATIONS

NASA (Canberra)
AGPS

ABSTRACTING AND INFORMATION ORGANISATIONS

INSPEC: Acquisitions Section Institution of Electrical Engineers
Library, Chemical Abstracts Reference Service
Engineering Societies Library, US
Materials Information, Cambridge Science Abstracts
Documents Librarian, The Center for Research Libraries, US

INFORMATION EXCHANGE AGREEMENT PARTNERS

Acquisitions Unit, Science Reference and Information Service, UK
Library - Exchange Desk, National Institute of Standards and Technology, US

OUTSIDE AUSTRALIA

Brent Gindelberger,
Survivability Vulnerability Information Analysis Center
Booz-Allen & Hamilton Inc.
WL/FIVS/SURVIAC, Bldg. 45
2130 Eighth St., Suite 1
Wright-Patterson AFB, OH 45433-7542, USA

Bill McBride,
Effectiveness Analysis Section,
Naval Air Warfare Center Weapons Division
1 Administration Circle
China Lake, CA 93555-6001, USA

SPARES (10 copies)

Total number of copies: 71

DEFENCE SCIENCE AND TECHNOLOGY ORGANISATION DOCUMENT CONTROL DATA				1. PRIVACY MARKING/CAVEAT (OF DOCUMENT)	
2. TITLE A Programmer's Reference to the Suppressor Simulation System			3. SECURITY CLASSIFICATION (FOR UNCLASSIFIED REPORTS THAT ARE LIMITED RELEASE USE (L) NEXT TO DOCUMENT CLASSIFICATION) Document (U) Title (U) Abstract (U)		
4. AUTHOR(S) Robert Whitehurst, Jane Phipps and Victor Kowalenko			5. CORPORATE AUTHOR Aeronautical and Maritime Research Laboratory PO Box 4331 Melbourne Vic 3001		
6a. DSTO NUMBER DSTO-GD-0130		6b. AR NUMBER AR-010-154		6c. TYPE OF REPORT General Document	
7. DOCUMENT DATE February 1997					
8. FILE NUMBER M1/9/322		9. TASK NUMBER DST 94/211		10. TASK SPONSOR DSTO	
				11. NO. OF PAGES 170	
				12. NO. OF REFERENCES -	
13. DOWNGRADING/DELIMITING INSTRUCTIONS None			14. RELEASE AUTHORITY Chief, Air Operations Division		
15. SECONDARY RELEASE STATEMENT OF THIS DOCUMENT <p style="text-align: center;"><i>Approved for public release</i></p> <p>OVERSEAS ENQUIRIES OUTSIDE STATED LIMITATIONS SHOULD BE REFERRED THROUGH DOCUMENT EXCHANGE CENTRE, DIS NETWORK OFFICE, DEPT OF DEFENCE, CAMPBELL PARK OFFICES, CANBERRA ACT 2600</p>					
16. DELIBERATE ANNOUNCEMENT No Limitations					
17. CASUAL ANNOUNCEMENT Yes					
18. DEFTEST DESCRIPTORS Mission (computer program), simulators, computer codes, modelling					
19. ABSTRACT This is a comprehensive reference to the Suppressor Simulation System, a powerful and flexible computer code which allows models of integrated military operations to be put into an Australian context. Such mission level models are vital ingredients to models of entire military campaigns.					

GENERAL DOCUMENT DSTO-GD-0130 AR-010-154 FEBRUARY 1997



AERONAUTICAL AND MARITIME RESEARCH LABORATORY
GPO BOX 4331 MELBOURNE VICTORIA 3001
AUSTRALIA, TELEPHONE (03) 9626 7000